Working Draft Project American National Standard

T13/2015-D

Information technology - ATA/ATAPI Command Set - 2 (ACS-2)

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ABSTRACT

This standard specifies the AT Attachment command set used to communicate between host systems and storage devices . This provides a common command set for systems manufacturers, system integrators, software suppliers, and suppliers of storage devices . The AT Attachment command set includes the PACKET feature set implemented by devices commonly known as ATAPI devices . This standard maintains a high degree of compatibility with the AT Attachment Interface with Packet Interface - 7 (ATA/ATAPI-7) volume 1 (see ANSI INCITS 397-2004).

Draft

American National Standard

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Document Status

Document e07172 is the issues list for this draft . e07172 contains a list of the issues associated with the document, an issue number that remains assigned to the issue for the life of document development, a resolution to the issue, an owner for the issue, and a disposition for the issue . All major changes associated with this draft are first documented in e07172 and given a number . This includes proposals which are targeted for inclusion into this draft . This text which is highlighted in green may affect backward compatibility.

	Revision History (part 1 of 5)	
Rev	**Date**	**Description**
0	September 16, 2008	1) Initial revision created from ATA8-ACSr6a
1	December 17, 2008	1) Added ACS2 column to historical tables in Annex B
		2) Removed asterisks from command matrix in Annex B and changed footnote to reference ATA8-ACS.
		3) Implemented issue #34 - changed all ranges to be ".." instead of x-y, x to y, and x - y.
		4) Implemented issue #50 - incorporated e08122r1 . Made a wording changes because ACS refers to log address names, not the address/page numbers.
		5) Implemented issue #8 - incorporated e07154r6, Data Set Management . Resources Assigned: IDENTIFY DEVICE data word 169, DCO IDENTIFY/SET word 21 bit 10, and Opcode 06h.
		6) Implement issue #18 - incorporate e07123r4, Request Sense for ATA . Resources Assigned: IDENTIFY DEVICE data words 119 and 120 bit 6, SET FEATURES subcommand C3h, and Opcode 0Bh . Marked this feature set as prohibited for ATAPI devices . Although the proposal marked the device field reserved, the legacy definition was inserted . Marked this as executable in the security table
		7) Implement issue #52 - Incorporate e08130r1, OEM ID String . Resources assigned: IDENTIFY DEVICE data words 170..173
		8) Implemented issue #61 . Added SCT Read Long to the definition of read command.
		9) Implemented issue #30 - incorporate e08106r10 . This updated the Device Statistics overview and provides a statistics directory.
		10) Implemented issue #24 - Incorporate e08128r1 . This adds an acronym list . Stole heading name and text from SAS2r14d.
		11) Implemented issue #63 - Add the definition of User Data . The definition of User Data Area should follow in a later revision.
		12) Implemented issue #60 - The READ PIO and READ DMA error tables appear to be the same . This was the result of adding ICRC to PIO commands.
		13) Implement issue #29 - Incorporate e08108r2 . This adds CFast Device as a new device type.
		14) Implemented issue #11 - Incorporate e06182r8 . This adds Free Fall device statistics as page 2.
		15) Updated the General Statistics page 1 to follow the template used for Free Fall . Assigned log address 04 page 02h for Free Fall statistics.
		16) Implemented issue #9 - Incorporate e06180r10 . This adds general usage statistics . Took a meeting vote which passed 7:0:5 to add this to page 1 (general statistics) . Active/Idle Power Loss Events were described in the text and removed from the table . Change rotating media usage statics to rotating media statistics . Assigned log address 04h page 03h for rotating media statistics.
		17) Implemented issue #10 - Incorporate e06181r12 . Assigned log address 4 page 03h for General Error Statistics

Revision History (part 2 of 5)		
Rev	Date	Description
1	December 17, 2008	18) Implemented issue #12 - Incorporate e06183r11 - Temperature Statistics . Assigned log address 4 page 05 . This proposal calls for the definition of a signed byte and none was provided . Added a definition of signed as a part of this proposal.
		19) Implanted issue #57 - Incorporate e08127r3 - Temperature Statistics . These statistics were added to log address 4 page 05.
		20) Implemented issue #33 - Incorporate e07168r11 - Transport Statistics . These statistics were assigned log address 4 page 06h.
		21) Implemented issue #59 - Incorporate e08137r4 - Deterministic Trim . Assigned IDENTIFY DEVICE data word 69 bit 14 to DRAT . This is a proposal against a proposal (e07154) . Added cross references in IDENTIFY DEVICE data word 169 bit 0 which were not in the proposal.
		22) Implemented issue #49 - Incorporate e08121r1 - Long Physical Sector Diagnostics . Assigned IDENTIFY DEVICE data word 69 bit 13 to indicate support for this new capability . Assigned IDENTIFY DEVICE data word 49 bits 1:0 to indicate the current setting . Word 49 bits 7:0 were previously marked retired and have been reclaimed by this proposal . Word 49 bits 7:2 are now marked reserved . Added a statement in the LPS feature set that makes Long Physical Sector Alignment Error Reporting Control optional for devices implementing the LPS feature set.
		23) Updated footers in the historical annex to say "*indicates new functionality for ACS-2"
		24) Split clause 7a into 3 separate files . Had to rebuild cross references . 7a was 1.5MB . new sizes: clause 7a=383K, clause 7b=1021K, clause 7c=390K, clause 7d=699K . Clause 7b only contains IDENTIFY DEVICE and IDENTIFY PACKET DEVICE...
		25) Implemented issue #38 - Incorporate e08129r2- New DMA commands . This provides DMA equivalents for all PIO commands with the exception of IDENTIFY DEVICE which is being updated to a log through a separate proposal . Modified this proposal to define a term DCO Set Command which refers to the DCO SET and DCO SET DMA commands . This change was also incorporated into the DCO state transition diagram . DEVICE CONFIGURATION has not been broken down by subcommand in the security table, no change was made for these new subcommands . Assigned opcode E9h to READ BUFFER DMA, 93h to DOWNLOAD MICROCODE DMA, EBh to WRITE BUFFER DMA . Assigned IDENTIFY DEVICE data word 69 bits 8-12 for reporting new commands . Did not add DCO and SET MAX subcommands to opcode list since subcommands are not in the opcode list.
		26) Implemented issue #62 - Incorporate e08154r0 . Added a number convention and a range convention.
		27) Implemented issue #25 . Added cross references to all words in the IDENTIFY DEVICE data table . Did not update IDENTIFY PACKET DEVICE data table.

Revision History (part 3 of 5)		
Rev	Date	Description
1a	March 2, 2009	1) Implemented issue #58, incorporate e08135r3 . Added Device Statistics page for SSD . Allocated page #7 for this set of statistics. 2) Implemented issue #36, incorporate e08140r1 . Changed wording in DCO SET error outputs to make partial command execution non-standard. 3) Implemented issue #69, incorporate e08153r1 . Obsoletes SCT Read/Write Long. 4) Implemented issue #42, checked all numbers to make sure that they follow the numeric convention which was inserted earlier. 5) Modified list of commands in 4.22.5 to remove the parenthetical statement which is not part of the command name. 6) Changed IDENTIFY DEVICE word 69 bit 15 to show that the bit is valid for the serial transport only. 7) Move the requirement listed at the top of the cell for IDENTIFY DEVICE word 93 from the table to the text at the end of the first paragraph. 8) Reworded the Enable/Disable extended status reporting feature set description to follow the same form as other SET FEATURES subcommands and include the subcommand code in the description. 9) Change the name of "Number of Shock Events Detected Where the Magnitude Exceeds Maximum Rating" to "Overlimit Shock Events" 10) Changed the revision level of the General Statistics log page (page 01) to 0002h . This was necessary because several statistics were added to this page.

Revision History (part 4 of 5)		
Rev	Date	Description
2	June 15, 2009	1) Implemented issue #74 - Recovered IDENTIFY DEVICE data words 224-233 from CE-ATA . CE-ATA is no longer an active organization. 2) Implemented issue #68 - Incorporate e08146r6 . Gives the device the ability to report the maximum number of LBA range entries for TRIM commands . Assigned IDENTIFY DEVICE word 105 to the proposal. 3) Implemented issue #46 - Incorporate e08152r2 . This obsoletes the TCQ feature set . The proposal did not address the tag and service bits found in the ATAPI commands, marked these bits obsolete as well . Some instances of the SERVICE command were missed in the command and history tables . Updated NOP command to make the Auto-poll and codes 2-FFh obsolete. 4) Implemented issue #54 - Incorporate e08143r3 . This proposal added new material from SATA 2.6 . This proposal required some re-formatting to match form and style . Removed the subclause on intermixing of NCQ commands, material was not appropriate for ACS-2. 5) Implemented issue #78 - Incorporate e09121r0 . Reserved a bit for IEEE-1667. 6) Implemented issue #53 - e08126r1 . Added protocol EDh 7) Implemented issue #77 - Incorporate e09122r1 - corrections to HPA state diagrams 8) Implemented issue #6 - Incorporate e08142r3 . Adds states to the power management state transition diagrams to support PUIS. 9) Implemented issue #72 - Incorporate e08158r1 . Changes reverting to defaults behavior to be compatible with ATA/ATAPI-7 10) Implemented issue #80 - Incorporate e09125r1 . Changes 28-bit commands from mandatory to optional . Normalize feature set statements to say optional for ATA devices instead of optional for devices that implement the General feature set . Glossary term was created and implemented inconsistently . READ SECTORS had to remain mandatory for ATAPI devices for legacy compatibility . Assigned IDENTIFY DEVICE data word 69 bit 6 to this proposal. 11) Implemented issue #76 - Incorporate e09117r1 . This adds the capability to report that the trim function causes the device to return all zeroes . Assigned IDENTIFY DEVICE data word 69 bit 5 to this capability. 12) Implement issue #28 - Incorporate e07197r8 . This is a PDF with markups from the meeting, no final copy was received . This adds the Sanitize Device feature set . Resources assigned to this proposal - opcode B4h and IDENTIFY DEVICE data word 59 bits 15:12 . There were many changes made during the implementation of this proposal which need to be closely checked. 13) Corrected integration error for e08135r3 . In A.5.7.3.2 the SSD Percentage Used Update Interval was listed at ten minutes . The proposal listed this as one hour . Changed the update interval to one hour. 14) Implement issue #45 - Incorporate e08120r12 . This adds several "power conditions" . These power conditions are sub-states for idle and standby . Assigned the following resources to this proposal - SET FEATURES subcommand 4Ah, Log Address: 08h, DCO IDENTIFY/SET word 21 bit 9, IDENTIFY DEVICE data words 119 and 120 bit 7. 15) Implement issue #79 - Incorporate e09118r1 . This adds an optional second method for reported extended status to the initiator . Renamed feature set to Sense Data Reporting. 16) Added comments from meeting reviews.

Revision History (part 5 of 5)		
Rev	**Date**	**Description**
2	June 15, 2009 (continued)	17) Regenerated table B.3 (commands sorted by command name) from table B.2 18) Spell Checked 19) Normalized period spacing and comma spacing.
3	June 18, 2010	1) The group decided the following during comment resolution: all 28-bit commands with an LBA have device field bit 6 set to obsolete; all 48-bit commands with an LBA have bit 6 set to one; and all 28-bit and 48-bit command have been normalized to N/A for bit 6 . This was implemented in the letter ballot comment resolutions (e09145r9). 2) Added APM level to IDENTIFY PACKET DEVICE data . This was marked reserved in previous text . However, the APM feature set is optional for ATAPI devices and there is a reference to this word in the feature set. 3) Integrated e09134r1 . This resolves several letter ballot comments against the Sanitize Device feature set . This proposal was incomplete in a couple areas. 4) normalized the first sentence of each command description to be of the form "The x command" This cause some additional rewriting in a few of the command intros. 5) Removed statements regarding the IDENTIFY PACKET DEVICE data from DCO SET streaming (word 7 bit 9), 48-bit (word 7 bit 8), SMART (word 7 bits 2:0) . Streaming, SMART, and 48-bit are prohibited from packet feature set devices. 6) Changed the form of bit referencing throughout DCO Set . This was due to numerous requests to spell out everything . The new form makes it easier to add references and to identify individual bits. 7) Added ACS-2 Revision 3 minor revision 8) Letter ballot commenting asked that Device field bit 6 (formerly CHS/LBA) change from "shall be set to 1" to "obsolete" for commands that have LBA/CHS capability . This brings the standard into line with current implementation practice. 9) Integrated e09115r1 . This describes padding requirements for TRUSTED IN/OUT commands . This was mistakenly left out of the draft after being approved earlier. 10) Normalized all the log names to be Name log . This follows the same form as Name feature set. 11) Integrated e09158r2 . This resolved several letter ballot comments against the Trim function. 12) Integrated f10106r1 . This creates a new place to return maximum LBA . This proposal was in response to a widespread limitation in application client side practices of limiting the size to 32 bits instead of 48 bits. 13) Integrated f10103r1 . Clarifies the reporting of EPC enabled. 14) Integrated e09154r3 . Clarifies the interactions of WRITE UNCORRECTABLE and LPS feature set. 15) Normalized Feature Set subclauses to be 48-bit/28-bit command is for xx feature set (ref) . There are 2 commands that are not part of a feature set (DSM & WU) . I think these should be added to the General feature set. 16) Incorporated f10125r0 . This removes the 7Fh Sense Data Reporting method and adds the Sense Data Available bit to all Normal and Error outputs.

New Capabilities added to ACS-2

Items indicated in bold are new functionality.

#	Doc	Description
		Integrated Proposal List
1	e08122r1	Two Minor Fixes for ACS-2
2	**e07154r6**	**Data Set Management - Adds a new command, DATA SET MANAGEMENT with one function (Trim) defined.**
3	**e08137r4**	**Adds a Deterministic Trim (DRAT) option to the DATA SET MANAGEMENT command's Trim function.**
4	**e09117r1**	**Adds a reporting option to indicate that DRAT always returns 0's.**
5	**e07123r4**	**Request Sense for ATA**
6	**e08130r1**	**OEM ID String - Adds an Additional Product Identifier to IDENTIFY DEVICE data**
7	e08106r10	Update device statistics overview and provide a statistics directory.
8	e08128r1	Acronym List
9	**e08108r2**	**Adds a new CFast device type**
10	**e06182r8**	**Adds a device statistics page to report free fall statistics**
11	**e06180r10**	**Adds General statistics and rotating media statistics**
12	**e06181r12**	**Adds General Error Statistics and more rotating media statistics**
13	e07172r9	Changed IDENTIFY DEVICE words 224-233 from 'Reserved for CE-ATA' to 'Reserved'
14	**e07188r1**	**Security Erase Update to allow FFh in addition to 00h**
15	e09115r1	Trusted Command Padding Cleanup
16	**e06183r11**	**Adds Temperature Statistics**
17	**e08127r3**	**Adds Temperature Statistics**
18	**e07168r11**	**Adds Transport Statistics**
19	**e08121r1**	**Long Physical Sector Diagnostics**
20	**e08129r2**	**Adds DMA equivalents for all PIO commands with the exception of IDENTIFY DEVICE**
21	e08154r0	Adds numbering and range conventions
22	**e08135r3**	**Adds SSD endurance indicator**
23	e08153r1	Obsoletes SCT Read/Write long.
24	**e08146r6**	**Allows the device to indicate the maximum number of 512-byte blocks that it will accept for Data Set Management commands**
25	e08152r2	Obsoletes the TCQ feature set

		Integrated Proposal List	
#	**Doc**	**Description**
26	e08143r3	Adds material from SATA 2.6
27	e09121r0	Reserves a bit for IEEE 1667 use
28	e08126r1	Synchronizes security protocol EDh with INCITS T10
29	e09122r1	Fixes issues with HPA state diagrams found in ATA8-ACS
30	e08142r3	Changes power management state diagrams to include PUIS
31	***e08158r1***	***Changes the polarity of reverting to defaults to match ATA/ATAPI-7***
32	e09125r1	Changes many 28-bit commands from mandatory to optional
33	**e07197r8**	**Adds the Sanitize Device feature set**
34	**e08120r12**	**Adds Extended Power Conditions (EPC)**
35	**e09118r1**	**Adds a second method to indicate that sense data is available**
36	e09134r1	Fixes Sanitize Device
37	e09115r1	Documents padding requirements for the trusted commands
38	e09158r2	Clarifies wordings associated with the Trim function
39	**f10106r1**	**Adds a new place to report the 48-bit capacity.**
40	f10103r1	Clarifies the reporting of EPC enabled . This bit is now command based instead of timer base.
41	e09154r3	Documents the interactions of WRITE UNCORRECTABLE and the LPS feature set
42	**f10125r0**	**Removes the Sense Data error signature 7Fh method . Additional sense data is always detected using bit 1 in the status field (i.e., Sense Data Available).**
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Contents

Tables

Figures

Foreword

(This foreword is not part of this standard.)

This standard is designed to maintain a high degree of compatibility with the ATA8-ACS standard.

Requests for interpretation, suggestions for improvement and addenda, or defect reports are welcome . They should be sent to the INCITS Secretariat, ITI, 1101 K Street NW, Suite 610, Washington, DC 20005.

This standard was processed and approved for submittal to ANSI by InterNational Committee for Information Technology Standards (INCITS) . Committee approval of this standard does not necessarily imply that all committee members voted for approval . At the time it approved this standard, INCITS had the following members:

Karen Higginbottom, Chair

David Michael, Vice-Chair

Monica Vago, Secretary

Technical Committee T13 on ATA Interfaces, that reviewed this standard, had the following members and additional participants:

Dan Colegrove, Chair

Jim Hatfield, Vice-Chair

Mark Overby, Secretary

[Editors Note: Insert T13 Membership List Here]

Introduction

This standard encompasses the following:
Clause 1 describes the scope.
Clause 2 provides normative references for the entire standard.
Clause 3 provides definitions, abbreviations, and conventions used within the entire standard.
Clause 4 describes the general operating requirements of the command layer.
Clause 5 describes the ATA protocols used by the commands in this standard.
Clause 6 describes Normal and Error Output fields.
Clause 7 describes commands.
Clause 8 describes the SCT Command Transport.
Clause 9 describes command normal and error outputs.
Annex A describes logs.
Annex B provides command summaries.
Annex C describes considerations for using devices with non-512-byte sectors.
Annex D provides a tutorial on how to use SCT.
Annex E provides implementation guidelines for 1 024/4 096 byte sectors.

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ATA/ATAPI Command Set - 2 (ACS-2)

1 Scope

The set of AT Attachment standards consists of this standard and the ATA implementation standards described in AT Attachment - 8 ATA/ATAPI Architecture Model (ATA8-AAM) . The ATA/ATAPI Command Set - 2 (ACS-2) standard specifies the command set host systems use to access storage devices . It provides a common command set for systems manufacturers, system integrators, software suppliers, and suppliers of intelligent storage devices . Figure 1 shows the relationship of this standard to the other standards and related projects in the ATA and SCSI families of standards and specifications.
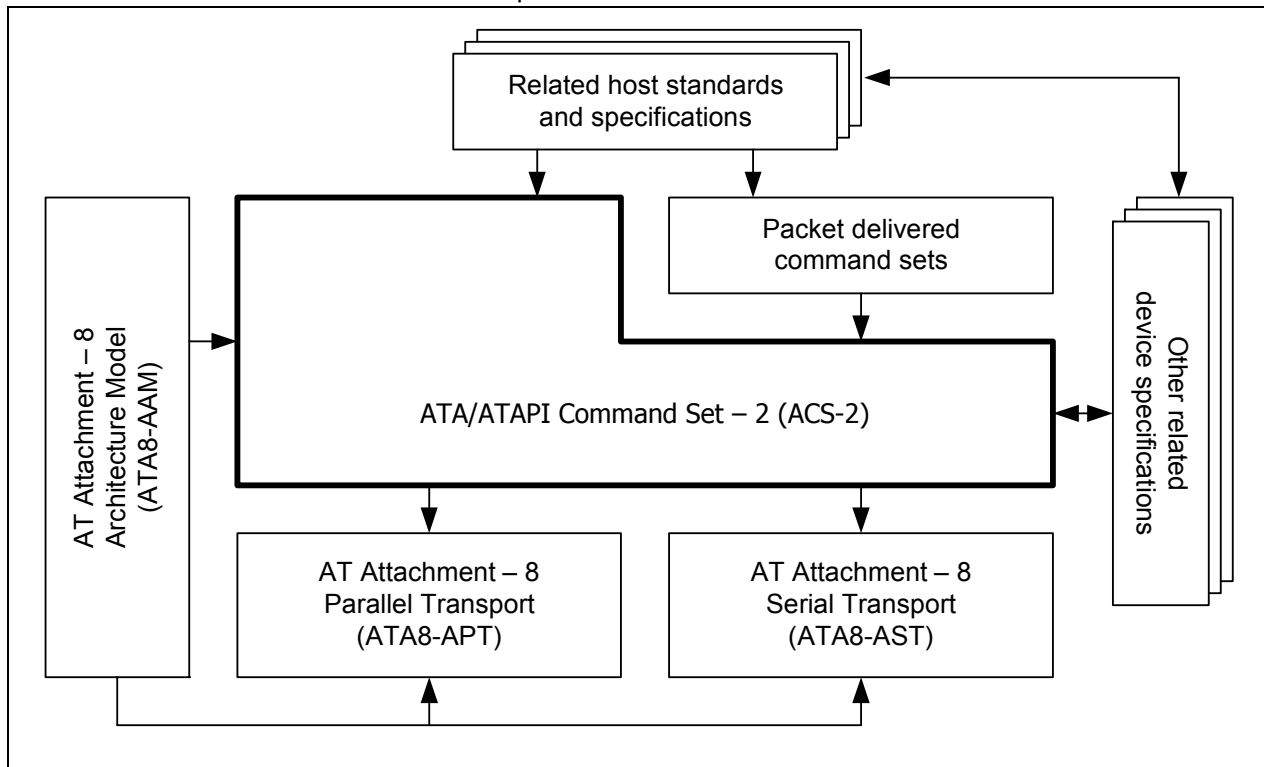
Figure 1 — ATA document relationships

This standard maintains compatibility with the ATA8-ACS standard, INCITS 452-2008, while providing additional functions.

2 Normative references

2.1 General

The standards listed in 2.2, 2.3, and 2.4 contain provisions that, through reference in the text, constitute provisions of this standard . At the time of publication, the editions indicated were valid . All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed in 2.2, 2.3, and 2.4.

Copies of these standards may be obtained from ANSI: Approved ANSI standards, approved and draft international and regional standards (ISO, IEC, CEN/CENELEC, ITUT), and approved and draft foreign standards (including BSI, JIS, and DIN) . For further information, contact ANSI Customer Service Department at 212-642-4900 (phone), 212-302-1286 (fax), or via the World Wide Web at http://www.ansi.org.

Additional availability contact information is provided as needed.

2.2 Approved references

Copies of the following documents may be obtained from ANSI, an ISO member organization:

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Table 1 lists approved ANSI standards, approved international and regional standards (ISO, IEC, CEN/CENELEC, ITUT) . Additional information may be available at http://www.t10.org and http://www.t13.org.

Table 1 — Approved ANSI References

Name	Reference
Protected Area Run Time Interface Extensions (PARTIES)	ANSI INCITS 346-2001
AT Attachment with Packet Interface Extension - 5 (ATA/ATAPI-5)	ANSI INCITS 340-2000
AT Attachment with Packet Interface Extension - 6 (ATA/ATAPI-6)	ANSI INCITS 361-2002
AT Attachment with Packet Interface Extension - 7 (ATA/ATAPI-7)	ANSI INCITS 397-2005 ISO/IEC 14776-971
ATA/ATAPI-7 Amendment 1	ANSI INCITS 397-2005/AM 1-2006
AT Attachment – 8 ATA/ATAPI Command Set (ATA8-ACS)	ANSI INCITS 452-2008
AT Attachment-8 - ATA/ATAPI Architecture Model (ATA8-AAM)	ANSI INCITS 451-2008
Time Limited Commands (TLC)	ANSI INCITS TR37-2004
SMART Command Transport (SCT)	ANSI INCITS TR38-2005
Acoustics - Measurement of airborne noise emitted by information technology and telecommunications equipment	ISO/IEC 7779:1999(E)
Information Systems - Coded Character Sets - 7-Bit American National Standard Code for Information Interchange (7-Bit ASCII)	ANSI INCITS 4-1986 (R2002)

2.3 References under development

At the time of publication, the referenced standards were still under development . For information on the current status of the document, or regarding availability, contact the relevant standards body or other organization as indicated in table 2.

Table 2 — References Under Development

Name	Project Number
AT Attachment-8 - Parallel Transport (ATA8-APT)	INCITS 1698D ISO/IEC 14776-881
Method to Disable Data Transfer after Error Technical Report (DDT)	INCITS 1825DT INCITS/TR-43
AT Attachment-8 - ATA Serial Transport (ATA8-AST)	INCITS 1697D
Host Bus Adapter - 2 (HBA-2)	INCITS 2014D
SCSI Primary Commands - 4 (SPC-4)	INCITS 1731D

2.4 Other references

These standards and specifications are also referenced.

CompactFlash Association Specification, Revision 4.1
> For the CompactFlash Association Specification published by the CompactFlash Association, contact the CompactFlash Association at http://www.compactflash.org.

The MultiMedia Card System Specification
> For the MultiMedia Card System Specification published by the MultiMedia Card Association, Inc, contact them at 925-417-0127 or http://www.mmca.org

RFC 3280, Internet X.509 Public Key Infrastructure: Certificate and Certificate Revocation List (CRL) Profile, IETF, 2002.
> For RFC 3280 contact the Internet Engineering Task Force at http://www.ietf.org.

RFC 3281, An Internet Attribute Certificate: Profile for Authorization, IETF, 2002
> For RFC 3281 contact the Internet Engineering Task Force at http://www.ietf.org

SDCard TrustedFlash Security Systems Specification 1.1.3
> For the SDCard TrustedFlash Security Systems Specification 1.1.3, contact them at http://www.sdcard.org

SD-ATA Interface Specification (Part H2)
> For the SD-ATA Interface Specification (Part H2), contact them at http://www.sdcard.org

Serial ATA revision 2.6 (SATA 2.6)
> For the SATA 2.6 specification published by SATA-IO, contact them at http://www.sata-io.org

CFast™, a CompactFlash™ Association Specification, Rev 1.0
> For the CFast Specification published by the CompactFlash™ Association, contact the CompactFlash™ Association at http://www.compactflash.org.

IEEE 1667 1.1 - Draft Standard Protocol for Authentication in Host Attachments of Transient Storage Devices
> For the IEEE 1667 standard, contact the IEEE 1667 Working Group at http://www.ieee1667.com.

3 Definitions, abbreviations, and conventions

3.1 Definitions and abbreviations

3.1.1   **28-bit command:** A command that uses Feature (7:0), Count (7:0), LBA (27:0), Device (15:8) and Command (7:0) to specify its arguments.

3.1.2   **48-bit command:** A command that uses Feature (15:0), Count (15:0), LBA (47:0), Device (15:8) and Command (7:0) to specify its arguments.

3.1.3   **application:** Software that is dependent on the services of an operating system.

3.1.4   **application client:** An object in the host that is the source of commands and device management functions (see ATA8-AAM).

3.1.5   **ASCII character:** A byte containing a 7-bit ASCII pattern in bits (6:0) with bit 7 cleared to zero.

3.1.6   **acoustics:** Measurement of airborne noise emitted by information technology and telecommunications equipment (see ISO 7779:1999(E)).

3.1.7   **ATA (AT Attachment) device:** A device implementing the General feature set (see 4.2).

3.1.8   **ATA string:** A set of ASCII characters (see 3.1.5) in the format specified in 3.3.10.

3.1.9   **ATAPI (AT Attachment Packet Interface) device:** A device implementing the PACKET feature set (see 4.3).

3.1.10   **AV (Audio-Video):** Audio-Video application data that is related to video images and/or audio (see 4.26).

3.1.11   **Background Activities:** Activities initiated by a command that occur after command completion has been reported.

3.1.12   **BIOS (Basic Input/Output System)**: An initial application client that is run when power is applied . The primary function of BIOS is to initialize various components (e.g . storage devices).

3.1.13   **block erase:** An internal media operation supported by some devices that sets a block of data to a vendor specific value (i.e., replacing previous data) and may precondition the media for write operations.

3.1.14   **byte:** A sequence of eight contiguous bits considered as a unit . See 3.3.9.

3.1.15   **cache:** A data storage area outside the area accessible by application clients that may contain a subset of the data stored in the non-volatile data storage area.

3.1.16   **CFA device:** A device implementing the CFA feature set (see 4.7) . CFA Devices may implement the ATA8-APT transport or the ATA8-AST transport (see CFast Device).

3.1.17   **CFA-APT device:** A CFA device that implements the ATA8-APT transport and not the ATA8-AST transport.

3.1.18   **CFast™ Device:** A CF form factor device that conforms to the SATA device requirements in this standard, implements the ATA8-AST transport and does not implement the ATA8-APT transport . CFast devices may support the CompactFlash™ feature set.

3.1.19   **check condition:** For ATAPI devices, this indicates an error or exception condition has occurred.

3.1.20   **circular buffer:** A buffer that is filled starting at the first byte continuing to the last byte and then wrapping to store data in the first byte of the buffer again.

3.1.21   **command aborted:** Command completion with the Error bit set to one in the Status field and Abort bit set to one in the Error field.

3.1.22   **command acceptance:** Positive acknowledgement of a command being received by a device . See the appropriate transport standard for a definition of positive acknowledgement.

3.1.23   **command completion:** The completion by the device of the action requested by the command or the termination of the command with an error, the setting of the appropriate bits in the Error field, and the setting of the appropriate bits in the Status field.

3.1.24 **command packet:** A data structure transmitted to the device during the processing of a PACKET command that includes the command and command parameters .

3.1.25 **COMRESET:** A commanded hardware reset in the Serial ATA transport (See SATA 2.6).

3.1.26 **Data Set**: A set of LBA Ranges used by the device as a single group.

3.1.27 **DCO Set:** A command which changes the device configuration . The following commands are DCO Set commands: DEVICE CONFIGURATION SET command (see 7.11.6) and DEVICE CONFIGURATION SET DMA command (see 7.11.7).

3.1.28 **device:** A data storage peripheral (e.g., a disk drive) (see 3.1.7 and 3.1.9).

3.1.29 **DMA (direct memory access) data transfer:** A means of data transfer between device and host memory without application client intervention.

3.1.30 **DRQ (Data Request) data block:** A number of logical sectors with available status when using either the PIO Data-In command protocol or the PIO Data-Out command protocol.

3.1.31 **DWord:** A sequence of four contiguous bytes considered as a unit . See 3.3.9.

3.1.32 **FIS:** The Frame Information Structure for the serial ATA interface (see ATA8-AST).

3.1.33 **free fall:** A vendor specific condition of acceleration.

3.1.34 **hardware reset:** The routine performed by a device after a hardware reset event as defined in ATA8-AAM.

3.1.35 **HPA Locked:** The condition of a device in the H2, HL1-HL6 or HEL1-HEL6 state.

3.1.36 **HPA Unlocked:** The condition of a device in the H0, H1, H3, HS1-HS6, or HES1-HES6 state (i.e. . states when the password may or may not be set).

3.1.37 **host:** An object that originates commands and device management functions (see ATA8-AAM).

3.1.38 **host adapter:** The implementation of the host transport, link, and physical layers.

3.1.39 **host interface:** The service delivery subsystem (see ATA8-AAM).

3.1.40 **Invalid LBA:** An LBA that is greater than or equal to the value reported in IDENTIFY DEVICE data words 100..103.

3.1.41 **Invalid LBA Range:** A range of LBAs that contains one or more invalid LBAs.

3.1.42 **LBA (logical block address):** The value used to reference a logical sector.

3.1.43 **logical block:** See logical sector (see 3.1.44).

3.1.44 **logical sector:** A set of logical words accessed and referenced as a unit (see IDENTIFY DEVICE data words 118:117 (see 7.18.7.61)) . These units are referenced by LBA (see 3.1.42).

3.1.45 **log:** A named sequence of one or more log pages (see Annex A).

3.1.46 **log address:** A numeric value that a log command uses to identify a specific log.

3.1.47 **log command:** A SMART READ LOG command (see 7.55.7), SMART WRITE LOG command (see 7.55.9), or GPL feature set (see 4.11) command.

3.1.48 **log page:** A 512-byte block of data.

3.1.49 **LSB (least significant bit):** In a binary code, the bit or bit position with the smallest numerical weighting in a group of bits that, when taken as a whole, represent a numerical value (e.g., in the number 0001b, the bit that is set to one).

3.1.50 **Master Password Capability:** Indicates if the Master password may be used to unlock the device.

3.1.51 **Media:** The material on which user data is stored.

3.1.52 **Media Access Command:** Any command that causes the device to access non-volatile media.

3.1.53 **MSB (most significant bit):** In a binary code, the bit or bit position with the largest numerical weighting in a group of bits that, when taken as a whole, represent a numerical value (e.g., in the number 1000b, the bit that is set to one).

3.1.54   **native max address:** The highest LBA that a device accepts as reported by DEVICE CONFIGURATION IDENTIFY data or as reduced by the DEVICE CONFIGURATION SET command (i.e., the highest LBA that is accepted by a device using the SET MAX ADDRESS command (see 7.51.2) or, if the 48-bit Address feature set is supported, then the highest value accepted by a device using the SET MAX ADDRESS EXT command (see 7.52)).

3.1.55   **Non-Volatile cache:** Cache that retains data through all reset events (e.g . power-on reset) . Non-volatile cache is a subset of the non-volatile media.

3.1.56   **Non-Volatile Media:** Physical storage media that retains data written to it for subsequent read operations through all reset events (e.g . power-on reset).

3.1.57   **NV Cache Pinned Set:** The set of logical blocks specified by the application client for which all user data accesses associated with those logical blocks are written to or read from the non-volatile cache.

3.1.58   **NV Cache Set:** The set of logical blocks represented in the device's entire NV Cache.

3.1.59   **NV Cache Set Data:** A data structure representing the standard format of transmitting logical blocks in the form of a list of LBA Range Entries.

3.1.60   **NV Cache Unpinned Set:** The set of logical blocks that are represented in the NV Cache Set but not represented in the NV Cache Pinned Set (see 4.17.1).

3.1.61   **partition:** A range of LBAs specified by an application client.

3.1.62   **Password Attempt Counter Exceeded:** A name associated with IDENTIFY DEVICE, word 128, bit 4 (see 7.18.7.66).

3.1.63   **PATA (Parallel ATA) device:** A device implementing the parallel ATA transport (see ATA8-APT).

3.1.64   **physical sector:** One or more contiguous logical sectors that are read from or written to the device media in a single operation.

3.1.65   **PIO (programmed input/output) data transfer:** Data transfers performed using PIO commands and protocol.

3.1.66   **power condition:** One of the following power management substates: Idle_a, Idle_b, Idle_c, Standby_y or Standby_z (see 4.9).

3.1.67   **power cycle:** the period from when power is removed from a host or device until the subsequent power-on event (see ATA8-AAM).

3.1.68   **power-on reset:** the host specific routine performed by the host or the routine performed by a device after detecting a power-on event (see ATA8-AAM).

3.1.69   **Queued Command:** A NCQ command that has reported command acceptance but not command completion.

3.1.70   **QWord:** A sequence of eight contiguous bytes considered as a unit . See 3.3.9.

3.1.71   **read command:** A command that causes the device to transfer data from the device to the host . The following commands are read commands: READ DMA, READ DMA EXT, READ DMA QUEUED, READ FPDMA QUEUED, READ MULTIPLE, READ MULTIPLE EXT, READ SECTOR(S), READ SECTOR(S) EXT, READ STREAM EXT, READ STREAM DMA EXT, READ VERIFY SECTOR(S), or READ VERIFY SECTOR(S) EXT.

3.1.72   **read stream command:** A command that causes the device to transfer data from the device to the host . The following commands are read stream commands: READ STREAM EXT and READ STREAM DMA EXT.

3.1.73   **SATA (Serial ATA) device:** A device implementing the serial ATA transport (see ATA8-AST).

3.1.74   **SCT Command:** A command that writes to the SCT command/status log (see clause 8).

3.1.75   **SCT Status:** A command that reads from the SCT command/status log (see clause 8).

3.1.76   **sector:** See logical sector (see 3.1.44) . For the definition of physical sector (see 3.1.64).

3.1.77   **Security Level:** See Master Password Capability (see 3.1.50).

3.1.78   **Serial ATAPI device:** A device implementing the serial ATA transport (see ATA8-AST) and the PACKET feature set.

3.1.79   **signature:** A unique set of values placed in the return parameters used to distinguish device types (e.g., General, ATAPI device, Port Multiplier) (see table 221).

3.1.80   **signed:** A value that is encoded using two's compliment.

3.1.81   **software reset:** The routine performed by a device after a software reset event as defined in ATA8-AAM . The software reset routine includes the actions defined in ATA8-AAM, this standard, and the applicable transport standards.

3.1.82   **spin-down:** The process of bringing a rotating media device's media to a stop.

3.1.83   **spin-up:** The process of bringing a rotating media device's media to operational speed.

3.1.84   **Stream:** A set of operating parameters specified by a host using the CONFIGURE STREAM command (see 7.9) to be used for subsequent READ STREAM commands and WRITE STREAM commands.

3.1.85   **transport:** The mechanism used to communicate with a device . See ATA8-APT and ATA8-AST.

3.1.86   **unaligned write:** A write command that does not start at the first logical sector of a physical sector or does not end at the last logical sector of a physical sector.

3.1.87   **unrecoverable error:** When the device sets either the Error bit or the Device Fault bit to one in the Status field at command completion.

3.1.88   **user data:** Data that is transferred between the application client and the device using read commands and write commands.

3.1.89   **user data area:** Any area of the device's media that stores user data and is addressable by the host from LBA 0 to DEVICE CONFIGURATION IDENTIFY data words 3..6.

3.1.90   **Volatile Cache:** Cache that does not retain data through power cycles.

3.1.91   **vendor specific:** Bits, bytes, fields, and code values that are reserved for vendor specific purposes . These bits, bytes, fields, and code values are not described in this standard, and implementations may vary among vendors . This term is also applied to levels of functionality whose definition is left to the vendor.

3.1.92   **word:** A sequence of two contiguous bytes considered as a unit . See 3.3.9.

3.1.93   **write command:** A command that causes the device to transfer data from the host to the device . The following commands are write commands: SCT Write Same, WRITE DMA, WRITE DMA EXT, WRITE DMA FUA EXT, WRITE FPDMA QUEUED, WRITE MULTIPLE, WRITE MULTIPLE EXT, WRITE MULTIPLE FUA EXT, WRITE SECTOR(S), WRITE SECTOR(S) EXT, WRITE STREAM DMA EXT, or WRITE STREAM EXT.

3.1.94   **write stream command:** A command that causes the device to transfer data from the host to the device . The following commands are write stream commands: WRITE STREAM DMA EXT and WRITE STREAM EXT

3.1.95   **WWN (world wide name):** A 64-bit worldwide unique name based upon a company's IEEE organizally unique identifier (OUI), reported in IDENTIFY DEVICE data words 108..111 (see 7.18.7.58) and IDENTIFY PACKET DEVICE data words 108..111 (see 7.19.6.44).

3.2 Symbols and abbreviations

Abbreviation	Meaning
*	multiplied by
/	divided by
<	less than
>	greater than
AAM	Automatic Acoustic Management
ACS	ATA/ATAPI Command Set
APM	Advanced Power Management
ASC	Additional Sense Code
ASCII	American Standard Code for Information Interchange
ASCQ	Additional Sense Code Qualifier
ASR	Asynchronous Signal Recovery
ATA	AT Attachment
ATAPI	AT Attachment with Packet Interface
ATA/ATAPI-5	AT Attachment with Packet Interface Extension - 5 (see 2.2)
ATA/ATAPI-6	AT Attachment with Packet Interface Extension - 6 (see 2.2)
ATA/ATAPI-7	AT Attachment with Packet Interface Extension - 7 (see 2.2)
ATA8-AAM	AT Attachment-8 - ATA/ATAPI Architecture Model (see 2.2)
ATA8-ACS	AT Attachment – 8 ATA/ATAPI Command Set (see 2.2)
ATA8-APT	AT Attachment-8 - Parallel Transport (see 2.3)
ATA8-AST	AT Attachment-8 - Serial Transport (see 2.3)
AV	Audio/Visual
BIOS	Basic I/O System
CDB	Command Descriptor Block (see SPC-4)
CFA	Compact Flash Association
CFast	Compact Flash ATA Serial Transport
CRC	Cyclic Redundancy Check
DCO	Device Configuration Overlay
DDT	Method to Disable Data Transfer after Error Technical Report (see 2.3)
DMA	Direct Memory Access
DRQ	Data ReQuest
EXT	Command used the extended (48-bit LBA) format parameters
FIS	Frame Information Structure
FUA	Forced Unit Access
GPL	General Purpose Logging
HBA	Host Bus Adapter
HBA-2	Host Bus Adapter - 2 (see 2.3)
HPA	Host Protected Area
INCITS	InterNational Committee for Information Technology Standards (see www.incits.org)
ISO	Organization for International Standards
LBA	Logical Block Address

Abbreviation	Meaning
LLS	Long Logical Sector
LPS	Long Physical Sector
LSB	Least Significant Bit
ms	milliseconds
MSB	Most Significant Bit
NCQ	Native Command Queueing
ns	nanoseconds
NV	Non-volatile
PARTIES	Protected Area Run Time Interface Extensions (see 2.2)
PATA	Parallel ATA
PIO	Programmed Input/Output
PUIS	Power-Up In Standby
RMW	Read-Modify-Write
SATA	Serial ATA
SATA-IO	Serial ATA International Organization (see www.sata-io.org)
SCT	SMART Command Transport (see 2.2)
SMART	Self-Monitoring Analysis and Reporting Technology
SPC-4	SCSI Primary Commands - 4 (see 2.3)
SSP	Software Settings Preservation
T10	INCTIS Technical Committee T10
TCG	Trusted Computing Group (see www.trustedcomputinggroup.org)
TLC	Time Limited Commands (see 2.2)
µs	microseconds
VS	Vendor Specific
WWN	World Wide Name

3.3 Conventions

3.3.1 Overview

Lowercase is used for words having the normal English language meaning . Certain words and terms used in this standard have a specific meaning beyond the normal English language meaning . These words and terms are defined either in clause 3 or in the text where they first appear.

The names of abbreviations, commands, fields, and acronyms used as signal names are in all uppercase (e.g., IDENTIFY DEVICE) . Fields containing only one bit are usually referred to as the "name" bit instead of the "name" field . (See 3.3.6 for the naming convention used for naming bits.)

Names of device fields begin with a capital letter (e.g., Count).

The expression "word n" or "bit n" shall be interpreted as indicating the content of word n or bit n.

3.3.2 Precedence

If there is a conflict between text, figures, and tables, the precedence shall be tables, figures, then text.

3.3.3 Lists

3.3.3.1 Lists overview

Lists shall be introduced by a complete grammatical proposition followed by a colon and completed by the items in the list.

Each item in a list shall be preceded by an identification with the style of the identification being determined by whether the list is intended to be an ordered list or an unordered list.

If the item in a list is not a complete sentence, then the first word in the item shall not be capitalized . If the item in a list is a complete sentence, then the first word in the item shall be capitalized,

Each item in a list shall end with a semicolon, except the last item, which shall end in a period . The next to the last entry in the list shall end with a semicolon followed by an "and" or an "or" (i.e., "...; and", or "...; or") . The "and" is used if all the items in the list are required . The "or" is used if only one or more items in the list are required.

3.3.3.2 Unordered lists

An unordered list is one in which the order of the listed items is unimportant (i.e., it does not matter where in the list an item occurs as all items have equal importance) . Each list item shall start with a lower case letter followed by a close parenthesis . If it is necessary to subdivide a list item further with an additional unordered list (i.e., have a nested unordered list), then the nested unordered list shall be indented and each item in the nested unordered list shall start with an upper case letter followed by a close parenthesis.

The following is an example of an unordered list with a nested unordered list:

The following are the items for the assembly:

    a) a box containing:
        A) a bolt;
        B) a nut; and
        C) a washer;
    b) a screwdriver; and
    c) a wrench.

3.3.3.3 Ordered lists

An ordered list is one in which the order of the listed items is important (i.e., item n is required before item n+1) . Each listed item starts with an Western-Arabic numeral followed by a close parenthesis . If it is necessary to subdivide a list item further with an additional unordered list (i.e., have a nested unordered list), then the nested unordered list shall be indented and each item in the nested unordered list shall start with an upper case letter followed by a close parenthesis.

The following is an example of an ordered list with a nested unordered list:

The following are the instructions for the assembly:

    1) remove the contents from the box;
    2) assemble the item;
        A) use a screwdriver to tighten the screws; and
        B) use a wrench to tighten the bolts;
        and
    3) take a break.

3.3.4 Keywords

Several keywords are used to differentiate between different levels of requirements and options.

3.3.4.1 expected: A keyword used to describe the behavior of the hardware or software in the design models assumed by this standard . Other hardware and software design models may also be implemented.

3.3.4.2 mandatory: A keyword indicating items to be implemented as defined by this standard.

3.3.4.3 may: A keyword that indicates flexibility of choice with no implied preference.

3.3.4.4 N/A: A keyword that indicates a field is not applicable and has no defined value and should not be checked by the host or device.

3.3.4.5 obsolete: A keyword indicating that the designated bits, bytes, words, fields, and code values that may have been defined in previous standards are not defined in this standard and shall not be reclaimed for other uses in future standards . However, some degree of functionality may be required for items designated as "obsolete" to provide for backward compatibility .

Obsolete commands should not be used by the host . Commands defined as obsolete may be command aborted by devices conforming to this standard . However, if a device does not return command aborted for an obsolete command, then the device shall return command completion for the command.

3.3.4.6 optional: A keyword that describes features that are not required by this standard . However, if any optional feature defined by the standard is implemented, the feature shall be implemented in the way defined by the standard.

3.3.4.7 prohibited: A keyword indicating that an item shall not be implemented by an implementation.

3.3.4.8 reserved: A keyword indicating reserved bits, bytes, words, fields, and code values that are set aside for future standardization . Their use and interpretation may be specified by future extensions to this or other standards . A reserved bit, byte, word, or field shall be cleared to zero, or in accordance with a future extension to this standard . The recipient shall not check reserved bits, bytes, words, or fields . Receipt of reserved code values in defined fields shall be considered a command parameter error and reported by returning command aborted.

3.3.4.9 retired: A keyword indicating that the designated bits, bytes, words, fields, and code values that had been defined in previous standards are not defined in this standard and may be reclaimed for other uses in future standards . If retired bits, bytes, words, fields, or code values are used before they are reclaimed, they shall have the meaning or functionality as described in previous standards.

3.3.4.10 shall: A keyword indicating a mandatory requirement . Designers are required to implement all such mandatory requirements to ensure interoperability with other products that conform to this standard.

3.3.4.11 should: A keyword indicating flexibility of choice with a strongly preferred alternative . Equivalent to the phrase "it is recommended".

3.3.5 Numbering

A binary number is represented in this standard by any sequence of digits consisting of only the Western-Arabic numerals 0 and 1 immediately followed by a lower-case b (e.g., 0101b) . Underscores or spaces may be included between characters in binary number representations to increase readability or delineate field boundaries (e.g., 0 0101 1010b or 0_0101_1010b) .

A hexadecimal number is represented in this standard by any sequence of digits consisting of only the Western-Arabic numerals 0 through 9 and/or the upper-case English letters A through F immediately followed by a lower-case h (e.g., FA23h) . Underscores or spaces may be included between characters in hexadecimal number representations to increase readability or delineate field boundaries (e.g., B FD8C FA23h or B_FD8C_FA23h).

A decimal number is represented in this standard by any sequence of digits consisting of only the Arabic numerals 0 through 9 not immediately followed by a lower-case b or lower-case h (e.g., 25) . This standard uses the following conventions for representing decimal numbers:

    a)   the decimal separator (i.e., separating the integer and fractional portions of the number) is a period;
    b)   the thousands separator (i.e., separating groups of three digits in a portion of the number) is a space; and
    c)   the thousands separator is used in both the integer portion and the fraction portion of a number.

Table 3 shows some examples of decimal numbers using various numbering conventions.

Table 3 — Numbering conventions

French	English	This standard
0,6	0.6	0.6
3,141 592 65	3.14159265	3.141 592 65
1 000	1,000	1 000
1 323 462,95	1,323,462.95	1 323 462.95

A decimal number represented in this standard with an overline over one or more digits following the decimal point is a number where the overlined digits are infinitely repeating (e.g., 666.6 means 666.666 666.. . or 666 2/3, and 12.142 857 means 12.142 857 142 857.. . or 12 1/7).

3.3.6 Bit conventions

Name (n:m), where n shall be greater than m, denotes a set of bits (e.g., Feature (7:0)) . n:m where n shall be greater than m denotes a bit range in a table.

3.3.7 Number range convention

p..q, where p is less than q, represents a range of numbers (e.g., words 100..103 represents words 100, 101, 102, and 103).

3.3.8 State diagram conventions

State diagrams shall be as shown in Figure 2.
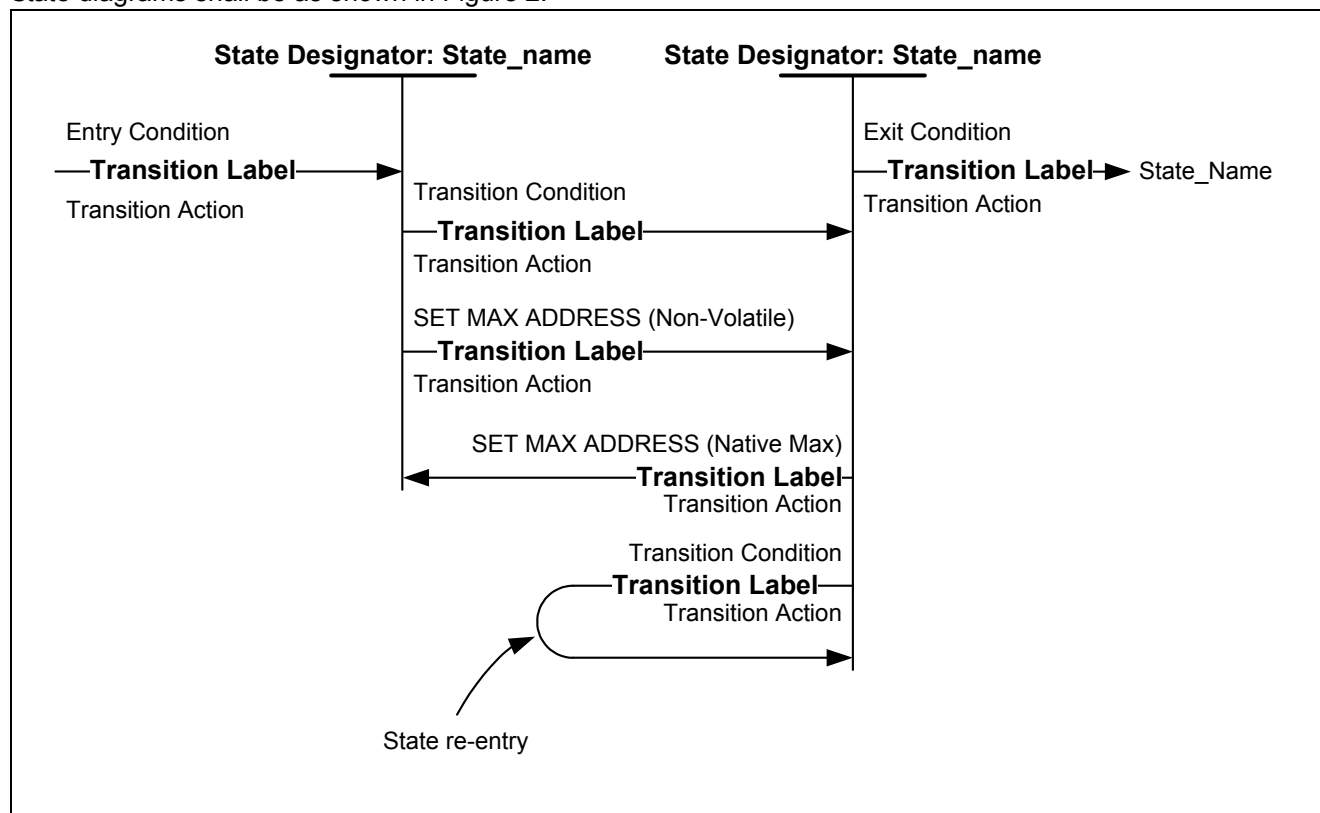
Figure 2 — State diagram convention

Each state is identified by a state designator and a state name . The state designator is unique among all states in all state diagrams in this standard . The state designator consists of a set of letters that are capitalized in the title of the figure containing the state diagram followed by a unique number . The state name is a brief description of the primary action taken during the state, and the same state name may appear in other state

diagrams . If the same primary function occurs in other states in the same state diagram, then the primary functions are designated with a unique letter at the end of the name . Additional actions may be taken while in a state and these actions are described in the state description text.

Each transition is identified by a transition label and a transition condition . The transition label consists of the state designator of the state from which the transition is being made followed by the state designator of the state to which the transition is being made . The transition to enter or exit a state diagram may come from or go to a number of state diagrams, depending on the command being processed . In this case, the state designator is labeled State_name . The transition condition is a brief description of the event or condition that causes the transition to occur and may include a transition action, indicated in italics, that is taken when the transition occurs . This action is described in the transition description text.

Upon entry to a state, all actions to be processed in that state are processed . If a state is re-entered from itself, all actions to be processed in the state are processed again.

All transitions shall be instantaneous.

The notation COMMAND (value) refers to the device receiving the command with a specific value or values . For example:

   a) SET MAX ADDRESS (Non-Volatile) means the device successfully processes a SET MAX ADDRESS command with the V_V field set to one; or
   b) SET MAX ADDRESS (Native Max) means the device successfully processes a SET MAX ADDRESS command with the LBA field set to the native max address.

If a state has a transition condition that specifies native max, then any other set max conditions imply a value less than the native max value . If a state has a transition condition that specifies neither volatile nor non-volatile, then both are implied.

If the (value) notation is not present on a transition, then the transition occurs for any parameter combination of the command.

3.3.9 Byte, word, DWord, and QWord Relationships

Figure 3 illustrates the relationship between bytes, words, DWords, and QWords.
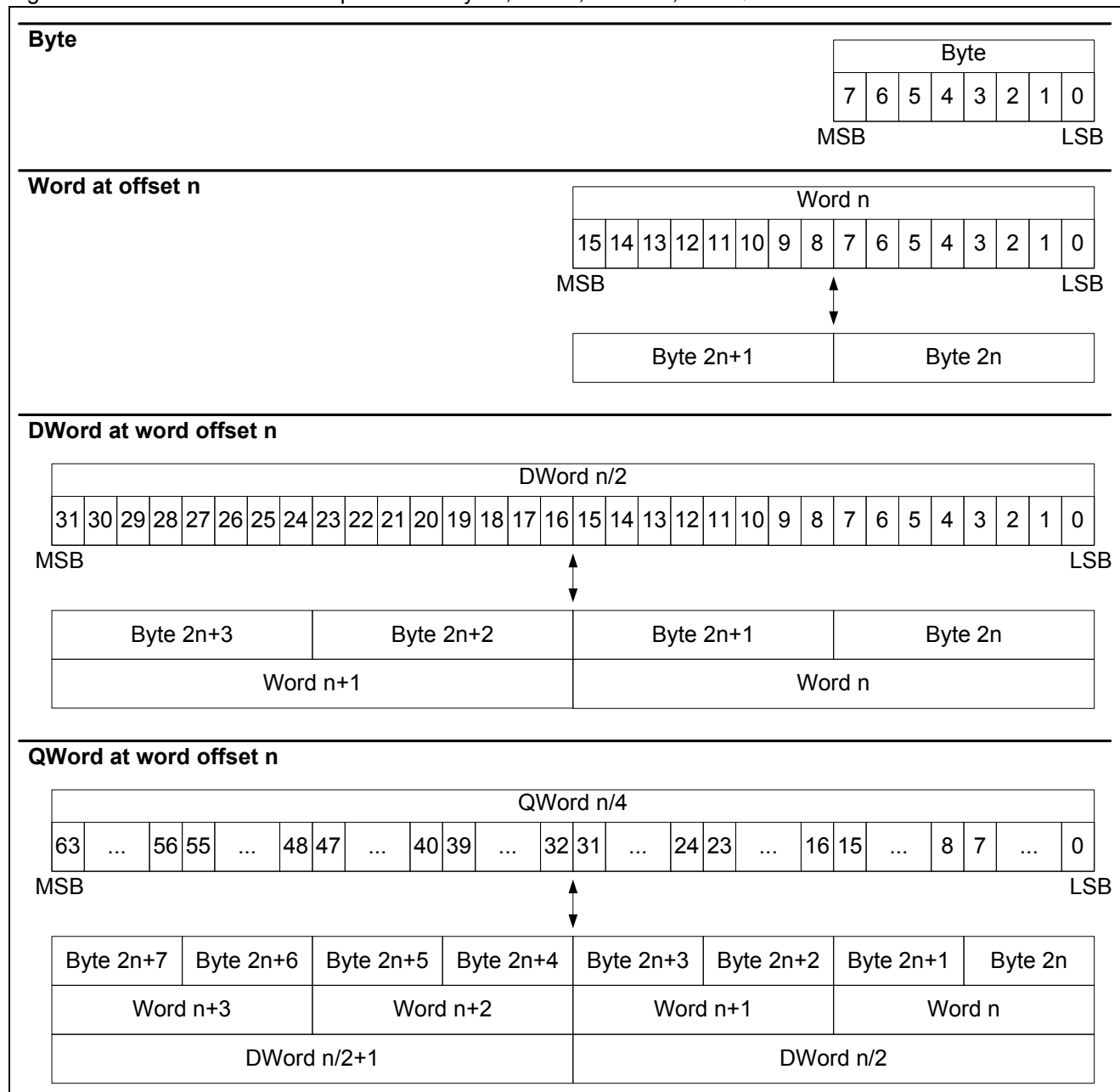
Figure 3 — Byte, word, DWord and QWord relationships

Unless stated or defined otherwise, in a field containing a multi-byte value (e.g., a word, DWord, or QWord), the byte containing the LSB is stored at the lowest offset and the byte containing the MSB is stored at the highest offset . Examples following this convention include:

    a)   Device Configuration Identify data (see table 39) and Device Configuration Overlay data (see table 43 in 7.11.6.6);

    b)   IDENTIFY DEVICE data (see table 54);

    c)   IDENTIFY PACKET DEVICE data (see table 65);

    d)   Request Pin data (see table 73), Cache Miss Data (see table 78), Pin Set Data (see table 80), and Remove Pin Data (see table 82) used by Non-Volatile Cache commands (see 7.22);

    e)   Device SMART data (see table 155);

    f)   SCT status response (see table 199) and SCT command (see table 200); and

g) Logs defined in Annex A.

For example:

a) if the two-byte field (i.e., word) in SCT command (see table 200) word 0 contains 0007h, then:
   A) byte 0 contains 07h; and
   B) byte 1 contains 00h;
b) if the four-byte field (i.e., DWord) at IDENTIFY DEVICE data words 60..61 (see table 54) contains 8001_0203h (i.e., 2 147 549 699), then:
   A) byte 120 contains 03h;
   B) byte 121 contains 02h;
   C) byte 122 contains 01h; and
   D) byte 123 contains 80h;

   and

c) if an eight-byte field (i.e., QWord) in the WRITE SAME command words 2..5 (see table 202) contains 0000_0504_0302_0100h), then:
   A) byte 4 contains 00h;
   B) byte 5 contains 01h;
   C) byte 6 contains 02h;
   D) byte 7 contains 03h;
   E) byte 8 contains 04h;
   F) byte 9 contains 05h;
   G) byte 10 contains 00h; and
   H) byte 11 contains 00h.

Exceptions to this convention include:

a) each field containing an ATA string (e.g., the IDENTIFY DEVICE data and IDENTIFY PACKET DEVICE data Serial number, Firmware revision, and Model number fields) is considered to be an array of bytes, not a multi-byte value, and is handled as described in 3.3.10;
b) the IDENTIFY DEVICE data and IDENTIFY PACKET DEVICE data World Wide Name field consists of four word fields rather than one QWord field and is handled as described in 7.18.7.58;
c) the CFA TRANSLATE SECTOR data LBA and logical sector write cycles count fields (see table 28);
d) the command packet in the PACKET command (see 7.24) is formatted as defined by the applicable command standard); and
e) parameter data in the TRUSTED RECEIVE command (see 7.59), TRUSTED RECEIVE DMA command (see 7.60), TRUSTED SEND command (see 7.61), and TRUSTED SEND DMA command (see 7.62) is formatted as defined in those sections or in the standard defining the security protocol.

3.3.10 ATA string convention

ATA strings are sequences of bytes containing ASCII graphic characters in the range of 20h-7Eh . ATA strings shall not contain values in the range of 00h-1Fh or 7Fh-FFh.

The following fields in IDENTIFY DEVICE data (see 7.18.7) and IDENTIFY PACKET DEVICE data (see 7.19.6) contain ATA strings:

a) Serial number (words 10..19) (see 7.18.7.10);
b) Firmware revision (words 23..26) (see 7.18.7.13);
c) Model number (words 27..46) (see 7.18.7.14); and
d) Current media serial number (words 176..205) (see 7.18.7.74).

Each pair of bytes in an ATA string is swapped as shown in table 4.

Table 4 — ATA string byte swapping

Word	Offset	Character in string
0	0	Second character
	1	First character
1	2	Fourth character
	3	Third character
...	...	...
n	2n	Last character
	2n+1	Second-to-last character

If the Firmware revision field (i.e., words 23..26) contains the string "abcdefg ", including one padding space character at the end, then the word and byte representations for the field are shown in table 5.

Table 5 — ATA firmware revision example

Word	Value	Offset	Value
23	6162h (i.e., "ba")	46	62h (i.e., "b")
		47	61h (i.e., "a")
24	6364h (i.e., "dc")	48	64h (i.e., "d")
		49	63h (i.e., "c")
25	6566h (i.e., "fe")	50	66h (i.e., "f")
		51	65h (i.e., "e")
26	6720h (i.e., " g")	52	20h (i.e., " ", the space character)
		53	67h (i.e., "g")

3.3.11 Offset Convention

An offset is a byte value used as an index into a larger data structure.

4 Feature set definitions

4.1 Overview

Table 6 lists the feature sets in alphabetical order and shows whether a feature set is mandatory, optional, prohibited, or not defined for ATA devices and ATAPI devices.

Table 6 — Feature Set Summary

Feature Set	ATA Devices	ATAPI Devices
48-Bit Address feature set (see 4.4)	O	P
Advanced Power Management (APM) feature set (see 4.5)	O	O
Automatic Acoustic Management (AAM) feature set (see 4.6)	O	O
CompactFlash Association (CFA) feature set (see 4.7)	N	N
Device Configuration Overlay (DCO) feature set (see 4.8)	O	O
Extended Power Conditions (EPC) feature set (see 4.9)	O	P
Free-fall Control feature set (see 4.10)	O	P
General feature set (see 4.2)	M	P
General Purpose Logging (GPL) feature set (see 4.11)	O	O
Host Protected Area (HPA) feature set (see 4.12)	O	O
Long Logical Sector (LLS) feature set (see 4.13)	O	P
Long Physical Sector (LPS) feature set (see 4.14)	O	P
Media Card Pass Through Command feature set (see 4.15)	N	P
Native Command Queuing (NCQ) feature set (see 4.16)	O	P
NV Cache feature set (see 4.17)	O	P
NV Cache Power Management feature set (see 4.18)	O	P
PACKET feature set (see 4.3)	P	M
Power Management feature set (see 4.19)	M	O
Power-Up In Standby (PUIS) feature set (see 4.20)	O	O
Sanitize Device feature set (see 4.21)	O	P
Security feature set (see 4.22)	O	O
Self-Monitoring, Analysis, and Reporting Technology (SMART) feature set (see 4.23)	O	P
Sense Data Reporting feature set (see 4.24)	O	P
Software Settings Preservation (SSP) feature set (see 4.25)	O	P
Streaming feature set (see 4.26)	O	P
Trusted Computing feature set (see 4.27)	O	P
Write-Read-Verify feature set (see 4.28)	O	P
Key: M – Mandatory, O – Optional, P – Prohibited, N – Not defined		

4.2 General feature set

The following General feature set commands are mandatory:

   a)   EXECUTE DEVICE DIAGNOSTIC (see 7.15);
   b)   IDENTIFY DEVICE (see 7.18); and
   c)   SET FEATURES (see 7.50).

The following General feature set commands are optional:

 a) DOWNLOAD MICROCODE (see 7.14);
 b) DOWNLOAD MICROCODE DMA (see 7.14)
 c) NOP (see 7.23);
 d) FLUSH CACHE (see 7.16);
 e) READ BUFFER (see 7.25);
 f) READ BUFFER DMA (see 7.26);
 g) READ DMA (see 7.27);
 h) READ MULTIPLE (see 7.32);
 i) READ SECTOR(S) (see 7.36);
 j) READ VERIFY SECTOR(S) (see 7.40);
 k) SET MULTIPLE MODE (see 7.53);
 l) WRITE BUFFER (see 7.63);
 m) WRITE BUFFER DMA (see 7.64);
 n) WRITE DMA (see 7.65);
 o) WRITE MULTIPLE (see 7.71);
 p) WRITE SECTOR(S) (see 7.74); and
 q) WRITE UNCORRECTABLE EXT (see 7.78).

The DEVICE RESET command, PACKET command, and IDENTIFY PACKET DEVICE command shall not be implemented.

4.3 The PACKET feature set

4.3.1 Overview

ATAPI devices use DEVICE RESET commands and PACKET commands as well as a subset of the General feature set to control the device.

The content of command packets delivered during execution of the PACKET command are defined in the standard indicated by IDENTIFY PACKET DEVICE data word 0 bits (12:8) (see 7.19.6.2) and are not described in this standard.

Devices implementing the PACKET feature set exhibit responses different from those exhibited by devices not implementing this feature set.

The following commands are mandatory for all devices implementing the PACKET feature set:

 a) DEVICE RESET (see 7.12);
 b) EXECUTE DEVICE DIAGNOSTIC (see 7.15);
 c) IDENTIFY DEVICE (see 7.18);
 d) IDENTIFY PACKET DEVICE (see 7.19);
 e) NOP (see 7.23);
 f) PACKET (see 7.24);
 g) READ SECTOR(S) (see 7.36); and
 h) SET FEATURES (see 7.50).

For ATAPI devices, the IDENTIFY DEVICE command (see 7.18) and the READ SECTOR(S) command (see 7.36) are command aborted and return the ATAPI device signature (see table 221).

The following commands are optional for all devices implementing the PACKET feature set:

 a) FLUSH CACHE (see 7.16);
 b) READ LOG DMA EXT (see 7.31);
 c) READ LOG EXT (see 7.30);
 d) WRITE LOG DMA EXT (see 7.70); and
 e) WRITE LOG EXT (see 7.69).

All commands that are not specified as mandatory or optional in this subclause and are defined in the General feature set shall not be implemented.

4.3.2 Identification of PACKET feature set devices

The IDENTIFY PACKET DEVICE command is used by the host to get identifying parameter information for a device implementing the PACKET feature set (see 7.18.5 and 7.19).

4.3.3 Signature for ATAPI devices

ATAPI devices return a signature that differentiate them from other device types (see table 221).

4.3.4 The PACKET command

The PACKET command allows a host to send a command to the device via a command packet . The command packet contains the command and command parameters that the device is to process (see clause 1).

The protocol for handling the transmission of the PACKET command and associated data is transport specific.

4.4 48-bit Address feature set

The 48-bit Address feature set allows devices:

   a) with capacities up to 281 474 976 710 655 logical sectors (i.e . up to 144 115 188 075 855 360 bytes for a 512-byte logical block device); and
   b) to transfer up to 65 536 logical sectors in a single command.

The following commands are mandatory for devices that implement the 48-bit address feature set:

   c) FLUSH CACHE EXT (see 7.17);
   d) READ DMA EXT (see 7.28);
   e) READ MULTIPLE EXT (see 7.33);
   f) READ SECTOR(S) EXT (see 7.37);
   g) READ VERIFY SECTOR(S) EXT (see 7.41);
   h) WRITE DMA EXT (see 7.66);
   i) WRITE DMA FUA EXT (see 7.67);
   j) WRITE MULTIPLE EXT (see 7.72);
   k) WRITE MULTIPLE FUA EXT (see 7.73); and
   l) WRITE SECTOR(S) EXT (see 7.75).

Devices implementing the 48-bit Address feature set shall also implement commands that use 28-bit addressing . 28-bit commands and 48-bit commands may be intermixed (see 7.1.3).

The device shall indicate:

   a) support of the 48-bit Address feature set in IDENTIFY DEVICE data word 83 bit 10 (see 7.18.7.40); and
   b) the maximum user LBA + 1 that is accessible by 48-bit addressable commands in IDENTIFY DEVICE data words 100..103 (see 4.12.4).

4.5 Advanced Power Management (APM) feature set

The Advanced Power Management feature set is an optional feature set that allows the host to select a power management level in a device . The power management level is specified using a scale from the lowest power consumption setting of 01h to the highest power consumption of FEh (i.e., maximum performance level), see table 124 . Device performance may increase with increasing power management levels . Device power consumption may increase as the power management setting numerically increases . A device may implement one APM method for two or more contiguous power management levels (e.g., a device may implement one APM method from level 80h to A0h and a higher performance, higher power consumption method from level A1h to FEh) . APM levels 80h and greater do not permit a device with rotating media to spin down as a result of an APM method.

The APM feature set uses the following subcommands:

   a) a SET FEATURES subcommand to enable APM (see 7.50.6); and
   b) an optional SET FEATURES subcommand to disable APM.

APM is independent of the Standby timer (see 4.19.3) . If both APM and the Standby timer are set, then the device shall go to the Standby state when the timer expires or the device's APM algorithm indicates that the Standby state should be entered.

The device shall indicate:

    a) feature set support in IDENTIFY DEVICE data word 83 bit 3 (see 7.18.7.40) and IDENTIFY PACKET DEVICE data word 83 bit 3 (see 7.19.6.34);

    b) feature set enabled in IDENTIFY DEVICE data word 86 bit 3 (see 7.18.7.41) and IDENTIFY PACKET DEVICE data word 86 bit 3 (see 7.19.6.35); and

    c) AAM level in IDENTIFY DEVICE data word 91 (see 7.18.7.45) and IDENTIFY PACKET DEVICE data word 91 (see 7.19.6.39).

The NV Cache Power management feature set may change the operation of the APM feature set (see 7.22.11).

4.6 Automatic Acoustic Management (AAM) feature set

The Automatic Acoustic Management feature set is an optional feature set that allows the host to select an acoustic management level . The acoustic management level ranges from the setting of 00h to FFh, although many levels are retired (see table 126) . Device performance and acoustic emanation may increase with increasing acoustic management levels . The acoustic management levels may contain discrete bands (e.g., a device may implement one acoustic management method from level 80h to A0h, and a higher performance, higher acoustic emanation method from level A1h to FEh).

The SET FEATURES subcommand disable AAM is optional for all devices implementing the AAM feature set:

The device shall indicate:

    a) feature set support in IDENTIFY DEVICE data word 83 bit 9 (see 7.18.7.40) and IDENTIFY PACKET DEVICE data word 83 bit 9 (see 7.19.6.34);

    b) feature set enabled in IDENTIFY DEVICE data word 86 bit 9 (see 7.18.7.41) and IDENTIFY PACKET DEVICE data word 86 bit 9 (see 7.19.6.35); and

    c) AAM level in IDENTIFY DEVICE data word 94 (see 7.18.7.48) and IDENTIFY PACKET DEVICE data word 94 (see 7.19.6.42).

The AAM setting may change the value of IDENTIFY DEVICE data word 97 (see 7.18.7.51).

4.7 CompactFlash Association (CFA) feature set

The optional CompactFlash Association (CFA) feature set provides support for devices that implement the CFA specifications . The following commands are mandatory for devices implementing the CFA feature set:

    a) CFA ERASE SECTORS (see 7.2);

    a) CFA REQUEST EXTENDED ERROR CODE (see 7.3);

    b) CFA TRANSLATE SECTOR (see 7.4);

    c) CFA WRITE MULTIPLE WITHOUT ERASE (see 7.5);

    d) CFA WRITE SECTORS WITHOUT ERASE (see 7.6); and

    e) SET FEATURES Enable/Disable 8-bit transfer (see 7.50.3).

Devices reporting the value 848Ah in IDENTIFY DEVICE data word 0 (see 7.18.7.2) or devices having IDENTIFY DEVICE data word 83 bit 2 (see 7.19.6.34) set to one shall support the CFA feature set . If the CFA feature set is implemented, then all the CFA commands and the Enable/Disable 8-Bit transfers shall be implemented.

Support of DMA commands is optional for devices that support the CFA feature set.

Devices indicating a one in IDENTIFY DEVICE data word 69 bit 15 shall support the CFast standard . CFast devices shall not support the Enable/Disable 8-bit transfers command . CFast devices may support the CompactFlash feature set . CFast devices shall follow the requirements for SATA devices.

4.8 Device Configuration Overlay (DCO) feature set

The optional DCO feature set allows an application client to reduce the capability of the device by modifying the capacity, commands, modes, and feature sets that a device indicates as supported in the IDENTIFY DEVICE data or IDENTIFY PACKET DEVICE data.

Commands unique to the DCO feature set use a single command code and are differentiated from one another by the value placed in the Feature field.

The following commands are mandatory for devices implementing the DCO feature set:

   a)   DEVICE CONFIGURATION FREEZE LOCK (see 7.11.2);
   b)   DEVICE CONFIGURATION IDENTIFY (see 7.11.3);
   c)   DEVICE CONFIGURATION RESTORE (see 7.11.5); and
   d)   DEVICE CONFIGURATION SET (see 7.11.6).

The following commands are mandatory for devices implementing the DCO feature set:

   a)   DEVICE CONFIGURATION IDENTIFY DMA (see 7.11.4); and
   b)   DEVICE CONFIGURATION SET DMA (see 7.11.7).

The DCO feature set may affect commands (e.g., IDENTIFY DEVICE data and IDENTIFY PACKET DEVICE data) . Certain bits in these words that indicate that a command, mode, capacity, or feature set is supported and enabled may be cleared by a DCO Set command . For a particular command, mode, capacity, or feature set, when a bit is changed from one to zero requesting that the device shall not indicate support for the feature, the device shall not provide the feature.

The DCO Set commands may be used to reduce the maximum capacity of the device . Since a Host Protected Area may be lost if the capacity of the device is reduced, when a Host Protected Area is set a DCO Set command shall cause the device to return command aborted . The LBA value returned by a READ NATIVE MAX ADDRESS command or READ NATIVE MAX ADDRESS EXT command is modified by the DCO Set commands modifying the maximum capacity of the device.

After processing of a power cycle or hardware reset, a device shall not change the settings made by a DCO Set command.

DEVICE CONFIGURATION IDENTIFY data indicates the selectable commands, modes, capacity, and feature sets that may be disabled in the device . After the processing of a DCO Set command the fields associated with the disabled commands, modes, capacity, and feature sets are modified in the IDENTIFY DEVICE data or IDENTIFY PACKET DEVICE data . DEVICE CONFIGURATION IDENTIFY data or DEVICE CONFIGURATION IDENTIFY DMA data is not changed by the DCO Set command or DEVICE CONFIGURATION RESTORE command.

A DEVICE CONFIGURATION RESTORE command enables all capabilities that have been disabled by the DCO Set commands and returns the IDENTIFY DEVICE data or IDENTIFY PACKET DEVICE data to that indicated by the DEVICE CONFIGURATION IDENTIFY data and DEVICE CONFIGURATION IDENTIFY DMA data . If the value returned in IDENTIFY DEVICE data words 100..103 is less than the native max address for a device (i.e., a host protected area has been established), then the device shall return command aborted for a DEVICE CONFIGURATION RESTORE command.

If a device has completed a DCO Set command without error, then a device shall be in the DCO Reduced_config state after processing a power cycle . If a device has not completed a DCO Set command (see figure 4) without error, then a device shall be in the DCO Factory_config state after processing a power cycle.

After completing a DEVICE CONFIGURATION FREEZE LOCK command without error, a device shall abort the following commands: DCO Set, DEVICE CONFIGURATION IDENTIFY, DEVICE CONFIGURATION IDENTIFY DMA, and DEVICE CONFIGURATION RESTORE until after completing the subsequent power cycle . If a device is in the DCO_locked state, then processing a hardware reset or software reset does not cause the device to change state.

If the DEVICE CONFIGURATION IDENTIFY DMA command is supported, then all references to the DEVICE CONFIGURATION IDENTIFY command in figure 4 also apply to the DEVICE CONFIGURATION IDENTIFY DMA command . If the DEVICE CONFIGURATION SET DMA command is supported, then all references to the

DEVICE CONFIGURATION SET command in figure 4 also apply to the DEVICE CONFIGURATION SET DMA command.
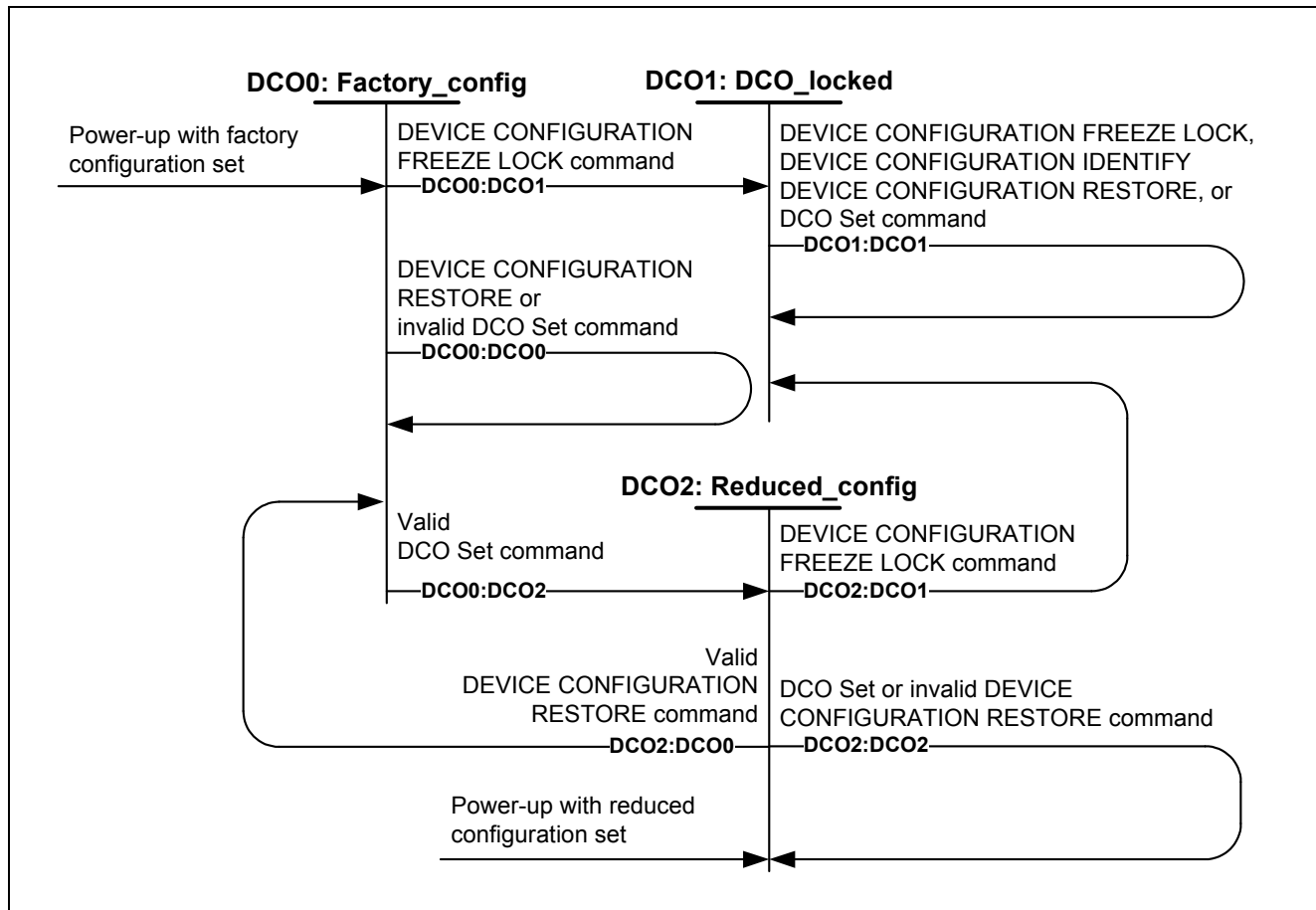
Figure 4 — Device Configuration Overlay state diagram

DCO0: Factory_config State: This state is entered when the device powers-up with the factory configuration set or a valid DEVICE CONFIGURATION RESTORE command is received .

When in this state, the device shall support all commands, modes, feature sets, and the capacity indicated by the response to a DEVICE CONFIGURATION IDENTIFY command or DEVICE CONFIGURATION IDENTIFY DMA command.

Transition DCO0:DCO0: When a DEVICE CONFIGURATION RESTORE command is received, the device shall return command aborted and transition to the DCO0: Factory_config state . If the device returns command aborted for a DCO Set command, then the device shall transition to the DCO0: Factory_config state . A device shall return command aborted if the DCO Set command requests that a device remove support for:

   a)   the HPA feature set (see 4.12) if a HPA has been established;
   b)   a Multiword or Ultra DMA mode if that mode or a higher numbered mode is currently selected;
   c)   the PUIS feature set (see 4.20) if the PUIS feature set has been enabled by a jumper;
   d)   the Security feature set (see 4.22) if the Security feature set has been enabled;
   e)   the SMART feature set (see 4.23) if the DCO Set data word 7 bits (2:1) are not cleared to zero; or
   f)   the SMART feature set (see 4.23) if the SMART feature set is enabled.

Transition DCO0:DCO1: When a DEVICE CONFIGURATION FREEZE LOCK command is received, the device shall return successful command completion and transition to the DCO1: DCO_locked state.

Transition DCO0:DCO2: When a valid DCO Set command is received, the device shall return successful command completion and transition to the DCO2: Reduced_config state . See Transition DCO0:DCO0 for the

definition of conditions that make a DCO Set command invalid . This transition is made even if the configuration described by the DCO Set command is the same as the factory configuration.

DCO1: DCO_locked State: This state is entered when a DEVICE CONFIGURATION FREEZE LOCK command is received.

When in this state, all the following commands: DEVICE CONFIGURATION FREEZE LOCK, DEVICE CONFIGURATION IDENTIFY, DEVICE CONFIGURATION IDENTIFY DMA, DCO Set, or DEVICE CONFIGURATION RESTORE shall return command aborted and shall remain in the same state.

Transition DCO1:DCO1: When one of the following commands is received: DEVICE CONFIGURATION FREEZE LOCK, DEVICE CONFIGURATION IDENTIFY, DEVICE CONFIGURATION IDENTIFY DMA, DCO Set, or DEVICE CONFIGURATION RESTORE, the device shall return command aborted and shall remain in the same state.

DCO2: Reduced_config State: This state is entered when the device powers-up with a reduced configuration set or a valid DCO Set command is received .

When in this state, the device shall support all commands, modes, feature sets, and the capacity specified by the DCO Set command that caused this state to be entered.

Transition DCO2:DCO1: When a DEVICE CONFIGURATION FREEZE LOCK command is received, the device shall return successful command completion and transition to the DCO1: DCO_locked state.

Transition DCO2:DCO0: When a valid DEVICE CONFIGURATION RESTORE command is received, the device shall return successful command completion and transition to the DCO0: Factory_config state . See Transition DCO2:DCO2 for the definition of conditions that make a DEVICE CONFIGURATION RESTORE command invalid.

Transition DCO2:DCO2: When a DCO Set command is received, the device shall return command aborted and transition to the DCO2: Reduced_config state . When an invalid DEVICE CONFIGURATION RESTORE command is received, the device shall return command aborted and transition to the DCO2: Reduced_config state . A DEVICE CONFIGURATION RESTORE command is invalid if a Host Protected Area has been established using the SET MAX ADDRESS command.

4.9 Extended Power Conditions (EPC) feature set

4.9.1 Overview

The Extended Power Conditions feature set provides a host with additional methods to control the power condition of a device . These methods include:

    a) defining power conditions within the PM1:Idle power management state (i.e., Idle_a, Idle_b and Idle_c);
    b) specifying that the device transition to a power condition without delay;
    c) enabling and initializing any of the power condition timers to specify that the device wait for a period of inactivity before transitioning to a specified power condition; and
    d) allowing the host to determine the power condition settings of the device.

The following command-related device properties are mandatory if this feature set is supported:

    a) the SET FEATURES Extended Power Conditions subcommand (see 7.50.19);
    b) the Power Conditions log (see A.8);
    c) additional status values returned by the CHECK POWER MODE command (see 7.8);
    d) IDENTIFY DEVICE data fields; and
    e) DCO controls.

4.9.2 Power conditions

Idle_a, Idle_b, and Idle_c are power conditions within the PM1:Idle power management state . Standby_y and Standby_z are power conditions within the PM2:Standby power management state . The power conditions shall be ordered from highest power consumption (i.e., shortest recovery time) to lowest power consumption (i.e., longest recovery time) as follows:

> Idle_a power >= Idle_b power >= Idle_c power >= Standby_y power >= Standby_z power

The Standby timer is controlled using:

 a) EPC subcommands;
 b) the IDLE command; or
 c) the STANDBY command.

The EPC feature set also defines a default Standby timer value that is controlled in the same manner as the other EPC power conditions (e.g., enabled, disabled, or queried).

Each of these power conditions has a set of current, saved and default settings (see A.8) . Default settings are not modifiable . Default and saved settings shall persist across power cycles . The current settings shall not persist across power cycles.

4.9.3 Power condition timers

The device shall have manufacturer specified power-on default settings for the power condition timers . Power condition timers are changeable with the SET FEATURES Extended Power Conditions subcommand (see 7.50.19) . Configured settings for the timers shall be readable in the Power Conditions log (see A.8).

A power condition timer set to zero indicates that the associated power condition is disabled .

The IDENTIFY DEVICE command indicates if this feature set is supported, and if there are power condition timers enabled.

If the power condition is enabled, then the value of each timer specifies the time after command completion that the device shall wait before transitioning to the power condition . All enabled power condition timers run concurrently .

If a command is accepted that requires a transition to PM0:Active, then the timers shall be stopped . If a command is accepted that does not require a transition to PM0:Active (e.g., a CHECK POWER MODE command), then the timers shall continue to run.

On command completion all timers that were stopped shall be initialized with the Current Timer settings values and started.

As a result of processing any command, the device may change to a different power condition.

When an enabled timer expires, the device shall transition to the power condition associated with that timer . Timer expirations shall only cause the device to transition from higher power conditions to lower power conditions (e.g., if the Standby_z timer is set to a smaller interval than the Idle_b timer, and the device is currently in the Standby_z power condition, then the device shall remain in the Standby_z power condition when the Idle_b timer expires) . If the timer expiration qualifies the device to transition to more than one enabled power condition, then the device shall transition to the power condition with the least power consumption.

4.9.4 Interaction with resets, commands and other features

On successful processing of a power cycle, the device shall:

 1) stop all EPC timers;
 2) copy the Saved Timer Enabled field to the Current Timer Enabled field, for all supported power conditions;
 3) copy the Saved Timer Settings field to the Current Timer Settings field, for all supported power conditions; and
 4) reinitialize and restart all enabled EPC timers with Current values.

On successful processing of a hardware reset, a software reset, or a DEVICE RESET command, the device shall:

 1) stop all EPC timers;
 2) remain in the current power condition; and
 3) reinitialize and restart all enabled EPC timers with Current values.

On successful processing of the IDLE command and if the EPC feature set is supported, then:

 1) in the Standby_z section of the Power Conditions log, the device shall:

A) if the specified Standby timer value is non-zero, then the device shall set the Current Timer Enabled field to one and convert the specified Standby timer value to units of 100 milliseconds and set it as the Current Standby timer; and

B) if the specified Standby timer value is zero, then the device shall clear the Current Timer Enabled field to zero and clear the Current Standby timer field to zero;

2) if volatile write cache is enabled, then the device shall write all cached data to the medium for the device (e.g., as a device does in response to a flush command) prior to entering into any power condition that prevents accessing the media (e.g., before a hard drive stops its spindle motor during transition to the Standby_z power condition);

3) the device shall enter the PM1:Idle state; and

4) the device shall enter the Idle_a power condition.

On successful processing of the IDLE IMMEDIATE command and if the EPC feature set is supported, then:

1) if the unload feature was selected, then the device shall protect itself (see 7.21.2.2) . If volatile write cache is enabled, then the device shall retain data in the write cache and resume writing the cached data onto the media after receiving a Software Reset, a hardware reset, or any new command except IDLE IMMEDIATE with unload feature;

2) if the unload feature was not selected and volatile write cache is enabled, then the device shall write all cached data to the medium for the device (e.g., as a device does in response to a flush command) prior to entering into any power condition that prevents accessing the media (e.g., before a hard drive stops its spindle motor during transition to the Standby_z power condition);

3) the device shall enter the PM1:Idle state; and

4) the device shall enter the Idle_a power condition .

On successful processing of the STANDBY command and if the EPC feature set is supported, then:

1) in the Standby_z section of the Power Conditions log,
   A) if the specified Standby timer value is non-zero, then the device shall set the Current Timer Enabled field to one and convert the specified Standby timer value to units of 100 milliseconds and set it as the Current Standby timer; and
   B) if the specified Standby timer value is zero, then the device shall clear the Current Timer Enabled field to zero and clear the Current Standby timer field to zero;

2) if volatile write cache is enabled, then the device shall write all cached data to the medium for the device (e.g., as a device does in response to a flush command) prior to entering into any power condition that prevents accessing the media (e.g., before a hard drive stops its spindle motor during transition to the Standby_z power condition);

3) the device shall enter the PM2:Standby state; and

4) the device shall enter the Standby_z power condition.

On successful processing of the STANDBY IMMEDIATE command and if the EPC feature set is supported, then:

1) if volatile write cache is enabled, then the device shall write all cached data to the medium for the device (e.g., as a device does in response to a flush command) prior to entering into any power condition that prevents accessing the media (e.g., before a hard drive stops its spindle motor during transition to the standby power condition);

2) the device shall enter the PM2:Standby state; and

3) the device shall enter the Standby_z power condition.

The Extended Power Conditions and the Advanced Power Management features are mutually exclusive of each other . All EPC subcommands shall return command aborted if APM is enabled . The SET FEATURES Enable/Disable APM subcommands shall abort if IDENTIFY DEVICE data word 120 bit 7 is set to one.

If the NV Cache Power Management feature is enabled, then the expiration of an EPC timer shall not cause the device to transition to a lower power state until the NV Cache power mode timer expires.

During background activities, all EPC timers may be paused . On completion of the activity, any paused EPC timers shall be continued from where they were paused .

4.10 Free-fall Control feature set

The Free-fall Control feature set allows the device to attempt to protect itself in the event of free-fall detection . When this feature is enabled, upon detecting a free-fall event the device should protect the user data from damage . The implementation of free-fall detection and protection is vendor specific.

The following SET FEATURES subcommands are mandatory for devices implementing the Free-fall Control feature set:

- a) SET FEATURES subcommand to Enable the Free-fall Control feature set (see 7.50.15); and
- b) SET FEATURES subcommand to Disable the Free-fall Control feature set.

The Enable/Disable Free-fall Control subcommands shall be non-volatile . After the Free-fall Control feature set is enabled, the device shall keep this feature enabled until changed by the Enable/Disable Free-fall Control subcommands.

IDENTIFY DEVICE data word 120 bit 5 (see 7.18.7.41) or IDENTIFY PACKET DEVICE data word 120 bit 5 (see 7.19.6.35) indicates when the Free-fall Control feature set is enabled.

4.11 General Purpose Logging (GPL) feature set

The General Purpose Logging (GPL) feature set provides access to the logs in a device . These logs are associated with specific feature sets (e.g., SMART (see 4.23) and Streaming (see 4.26)) . Support of the individual logs (see table A.2) is determined by support of the associated feature set . If the device supports a particular feature set, support for any associated log(s) is mandatory.

Support for the GPL feature set shall not be disabled by disabling SMART . If the feature set associated with a requested log is disabled, the device shall return command aborted.

If the GPL feature set is implemented, the following commands shall be supported:

- a) READ LOG EXT; and
- b) WRITE LOG EXT.

The following commands are optional:

- a) READ LOG DMA EXT; and
- b) WRITE LOG DMA EXT.

If the GPL feature set is supported, all Host Specific logs shall be supported (see A.10).

4.12 Host Protected Area (HPA) feature set

4.12.1 HPA overview

The Host Protected Area (HPA) feature set provides a method for an application client to reduce the number of number of logical sectors within the user data area . This method results in providing a data storage area on the device that may be used by that application client but may temporarily be inaccessible to other application clients . A device that implements the HPA feature set shall implement the following minimum set of commands:

- a) READ NATIVE MAX ADDRESS;
- b) SET MAX ADDRESS.

A device that implements the HPA feature set and supports the 48-bit Address feature set (see 4.4) shall implement the following additional set of commands:

- a) READ NATIVE MAX ADDRESS EXT;
- b) SET MAX ADDRESS EXT.

Devices supporting this feature set shall set IDENTIFY DEVICE data word 82 bit 10 (see 7.19.6.34) to one.

> NOTE 1 — The PARTIES standard specifies a method for managing the HPA.

4.12.2 HPA security extensions

A device supporting the HPA feature set may optionally include the HPA security extensions . The Host Protected Area security commands use a single command code and are differentiated from one another by the value placed in the Feature field.

If the HPA security extensions are implemented, the following commands shall be supported:

a) SET MAX FREEZE LOCK (see 7.51.3); and
b) SET MAX LOCK (see 7.51.4);
c) SET MAX SET PASSWORD (see 7.51.5);
d) SET MAX UNLOCK (see 7.51.7).

If the HPA security extensions are implemented, the following commands are optional:

a) SET MAX SET PASSWORD DMA (see 7.51.6); and
b) SET MAX UNLOCK DMA (see 7.51.8).

Devices supporting these extensions shall set IDENTIFY DEVICE data word 82 bit 10 to one (see 7.18.7.40) or IDENTIFY PACKET DEVICE data word 82 bit 10 to one (see 7.19.6.34), and shall set IDENTIFY DEVICE data word 83 bit 8 to one (see 7.18.7.40) or IDENTIFY PACKET DEVICE data word 83 bit 8 to one (see 7.19.6.34).

Upon successful completion of a power cycle, the HPA security extensions are disabled and IDENTIFY DEVICE data word 86 bit 8 (see 7.18.7.41) is cleared to zero or IDENTIFY PACKET DEVICE data word 86 bit 8 (see 7.19.6.35) is cleared to zero . There is no valid HPA password after the device processes a power cycle and IDENTIFY DEVICE data word 86 bit 8 (see 7.18.7.41) is cleared to zero or IDENTIFY PACKET DEVICE data word 86 bit 8 (see 7.19.6.35) is cleared to zero.

If the SET MAX SET PASSWORD DMA command is supported, then all requirements and behaviors for the SET MAX PASSWORD command also apply to the SET MAX SET PASSWORD DMA command . If the SET MAX UNLOCK DMA command is supported, then all requirements and behaviors for the SET MAX UNLOCK command also apply to the SET MAX UNLOCK DM A command.

When a SET MAX SET PASSWORD command is completed without error, the HPA security extensions are enabled and IDENTIFY DEVICE data word 86 bit 8 (see 7.18.7.41) shall be set to one or IDENTIFY PACKET DEVICE data word 86 bit 8 (see 7.19.6.35) shall be set to one.

4.12.3 28-bit and 48-bit HPA commands interactions

The READ NATIVE MAX ADDRESS command or READ NATIVE MAX ADDRESS EXT command allows the host to determine the maximum native address space of the device even when a protected area has been allocated .

The SET MAX ADDRESS command or the SET MAX ADDRESS EXT command allows the host to redefine the maximum LBA of the user data area . That is, when the SET MAX ADDRESS command or SET MAX ADDRESS EXT command is issued with a maximum LBA less than the native max address, the device reduces the user data area to the maximum specified by the command, providing a protected area above that maximum LBA . See 4.12.4 for a description of how to set IDENTIFY DEVICE data after issuing a SET MAX ADDRESS command or SET MAX ADDRESS EXT command.

Any read or write that attempts to access an LBA above the maximum LBA specified by the SET MAX ADDRESS command or SET MAX ADDRESS EXT command shall cause command completion with the ID Not Found bit set to one and the Error bit set to one, or command aborted.

The V_V bit (see 7.51.2.3.2 and 7.52.3.2) in the Count field allows the host to specify if the LBA field in the SET MAX ADDRESS command is preserved after a power cycle or a hardware reset . After processing a power cycle or hardware reset, the device sets the maximum LBA to the last non-volatile LBA setting regardless of subsequent volatile SET MAX ADDRESS command or SET MAX ADDRESS EXT command . If the SET MAX ADDRESS command or SET MAX ADDRESS EXT command is issued with a value that exceeds the native max address, then the device shall return command aborted.

Software reset shall not:

a) affect the HPA feature set settings in the device;
b) change the maximum accessible LBA for the device; or

    c)   change the HPA state of the device.

When the device is HPA Unlocked and has not processed a SET MAX FREEZE LOCK command, then multiple SET MAX SET PASSWORD commands may be processed . The device only keeps the password set by the last SET MAX SET PASSWORD command . Previously received passwords are overwritten by the new password . There is no limit to the number of times the password may be set.

Typical use of these commands is:

Example 1: after a power cycle or a hardware reset is processed:

    1)   BIOS receives control after the reset;
    2)   BIOS issues a READ NATIVE MAX ADDRESS command or READ NATIVE MAX ADDRESS EXT command to find the max capacity of the device;
    3)   BIOS issues a volatile SET MAX ADDRESS command or SET MAX ADDRESS EXT command to the values returned by READ NATIVE MAX ADDRESS command or READ NATIVE MAX ADDRESS EXT command;
    4)   BIOS reads configuration data from the highest area on the disk; and
    5)   BIOS restores the protected area by issuing a non-volatile SET MAX ADDRESS command or SET MAX ADDRESS EXT command using the original LBA.

Example 2: on save to disk:

    1)   BIOS receives control prior to shut down;
    2)   BIOS issues a READ NATIVE MAX ADDRESS command or READ NATIVE MAX ADDRESS EXT command to find the max capacity of the device;
    3)   BIOS issues a volatile SET MAX ADDRESS command or SET MAX ADDRESS EXT command to the values returned by READ NATIVE MAX ADDRESS command or READ NATIVE MAX ADDRESS EXT command;
    4)   Memory is copied to the reserved area;
    5)   Shut down completes; and
    6)   After processing a power cycle or hardware reset, the device sets the maximum LBA to the last non-volatile LBA setting regardless of subsequent volatile SET MAX ADDRESS command or SET MAX ADDRESS EXT command.

> NOTE 2 — HPA feature set commands are intended for use only by system BIOS or other low-level boot time processes . Using HPA feature set commands outside BIOS controlled boot or shutdown may result in damage to file systems on the device.

The SET MAX SET PASSWORD command allows the host to define the password to be used during the current power cycle . The password does not persist after a power cycle has been processed but does persist after a hardware reset or a software reset has been processed . This password is not related to the password used for the Security feature set (see 4.22) . When the password is set the device is HPA Unlocked.

The SET MAX LOCK command provides a method for the host to disable the SET MAX commands, except the SET MAX UNLOCK command, until after the device has processed the next power cycle or command completion of a SET MAX UNLOCK command . When the SET MAX LOCK command is completed the device is HPA Locked.

The SET MAX UNLOCK command changes the device from HPA Locked to HPA Unlocked.

The SET MAX FREEZE LOCK command provides a method for the host to disable the SET MAX commands, including the SET MAX UNLOCK command, until after the device has processed the next power cycle.

4.12.4 IDENTIFY DEVICE data

If the host issues a SET MAX ADDRESS command or SET MAX ADDRESS EXT command, then several IDENTIFY DEVICE data words may be affected . The following guidelines are used for setting IDENTIFY DEVICE data:

    a)   if the 48-bit Address feature set (see 4.4) is not supported, then words 60..61 (see 7.18.7.22) shall contain the total number of user addressable logical sectors, words 100..103 (see 7.18.7.53) shall be reserved, and word 69 bit 4 (see 7.18.7.30) shall be cleared to zero;

b) if the 48-bit Address feature set (see 4.4) is supported and the total number of user addressable logical sectors is less than or equal to 0FFF_FFFFh, then

    A) words 60..61 (see 7.18.7.22) and words 100..103 (see 7.18.7.53) shall contain the total number of user addressable logical sectors; and

    B) if word 69 bit 4 (see 7.18.7.30) is set to one, then words 230..233 (see 7.18.7.89) shall contain the total number of user addressable sectors;

    and

c) if the 48-bit Address feature set is supported and the total number of user addressable logical sectors is greater than 0FFF_FFFFh, then words 60..61 (see 7.18.7.22) shall contain 0FFF_FFFFh and:

    A) if word 69 bit 4 (see 7.18.7.30) is cleared to zero, then words 100..103 (see 7.18.7.53) shall contain the total number of user addressable logical sectors; and

    B) If word 69 bit 4 (see 7.18.7.30) is set to one, then words 230..233 (see 7.18.7.89) shall contain the total number of user addressable sectors and words 100.103 (see 7.18.7.53) shall contain a value less than or equal to the total number of user addressable sectors and greater than 0000_0000_0FFF_FFFFh (e.g., words 100..103 (see 7.18.7.53) may be limited to 0000_0000_FFFF_FFFFh and the full capacity is reported in words 100..103 (see 7.18.7.53)).

4.12.5 Determination of SET MAX security extension status

When the device is HPA Locked IDENTIFY DEVICE data word 86 bit 8 (see 7.18.7.41) shall be set to one or IDENTIFY PACKET DEVICE data word 86 bit 8 (see 7.19.6.35) shall be set to one.

4.12.6 HPA State Transition Diagrams

4.12.6.1 State Transition Figures

The HPA state transition diagrams are in five parts: figure 5, figure 6, figure 7, figure 8, and figure 9.

See 3.3.8 for conventions that use the COMMAND (value) notation in these state transition diagrams.

In the following state transition diagrams:

a) if the SET MAX PASSWORD DMA command is supported, then all requirements and behaviors for the SET MAX PASSWORD command also apply to the SET MAX PASSWORD DMA command; and

b) if the SET MAX UNLOCK DMA command is supported, then all requirements and behaviors for the SET MAX UNLOCK command also apply to the SET MAX UNLOCK DMA command.
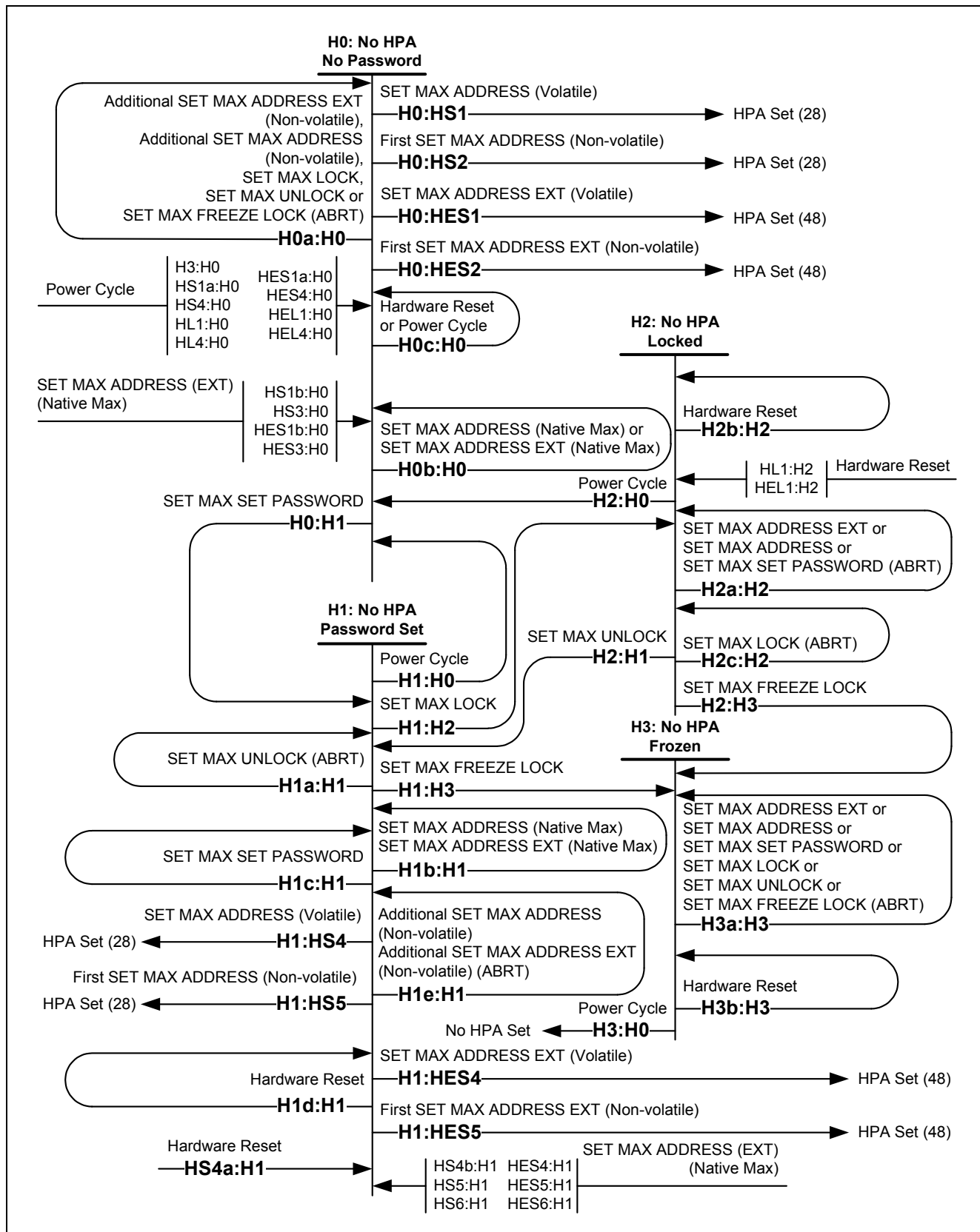
Figure 5 — HPA Not Set
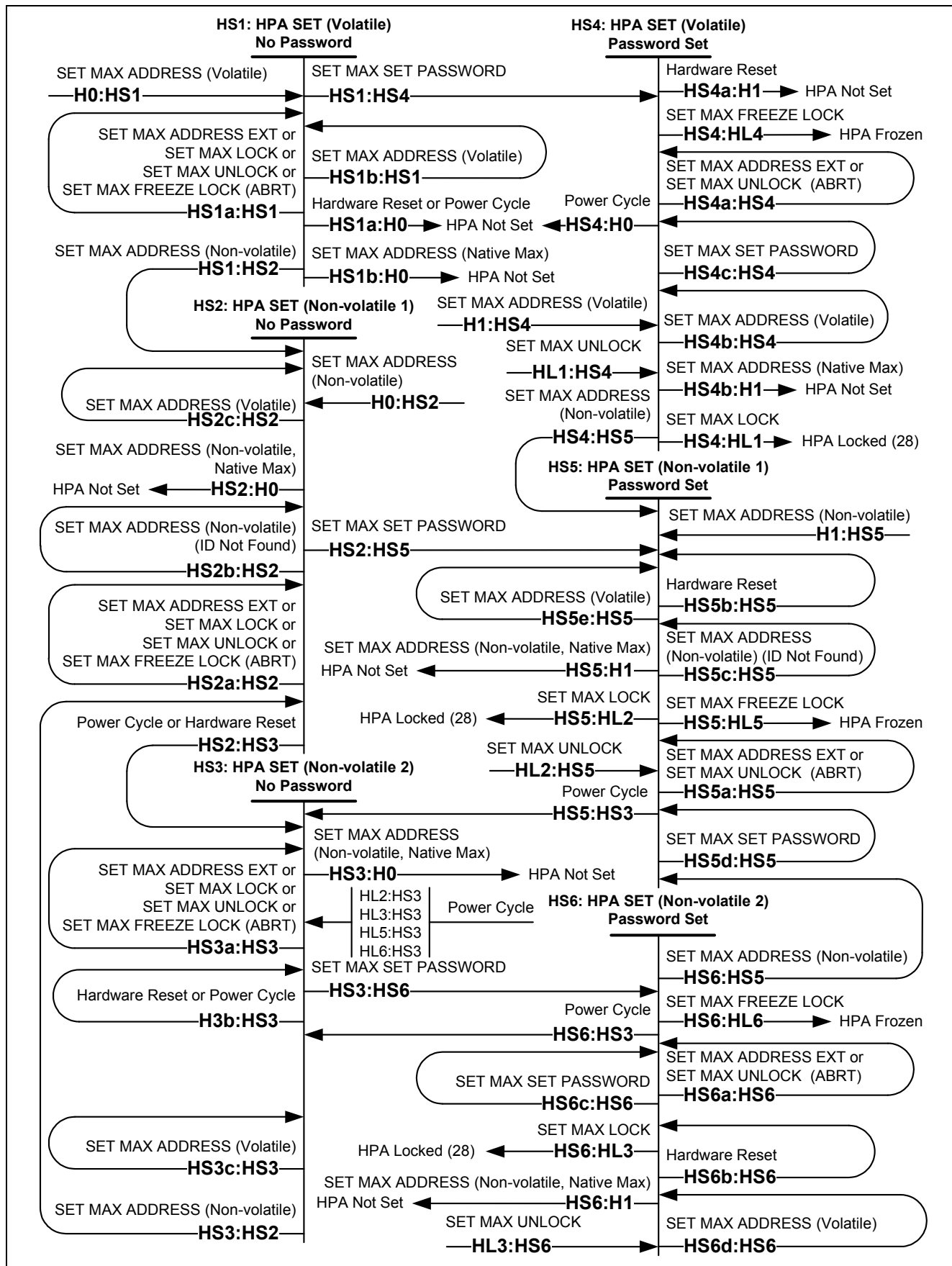
Figure 6 — HPA Set (28)
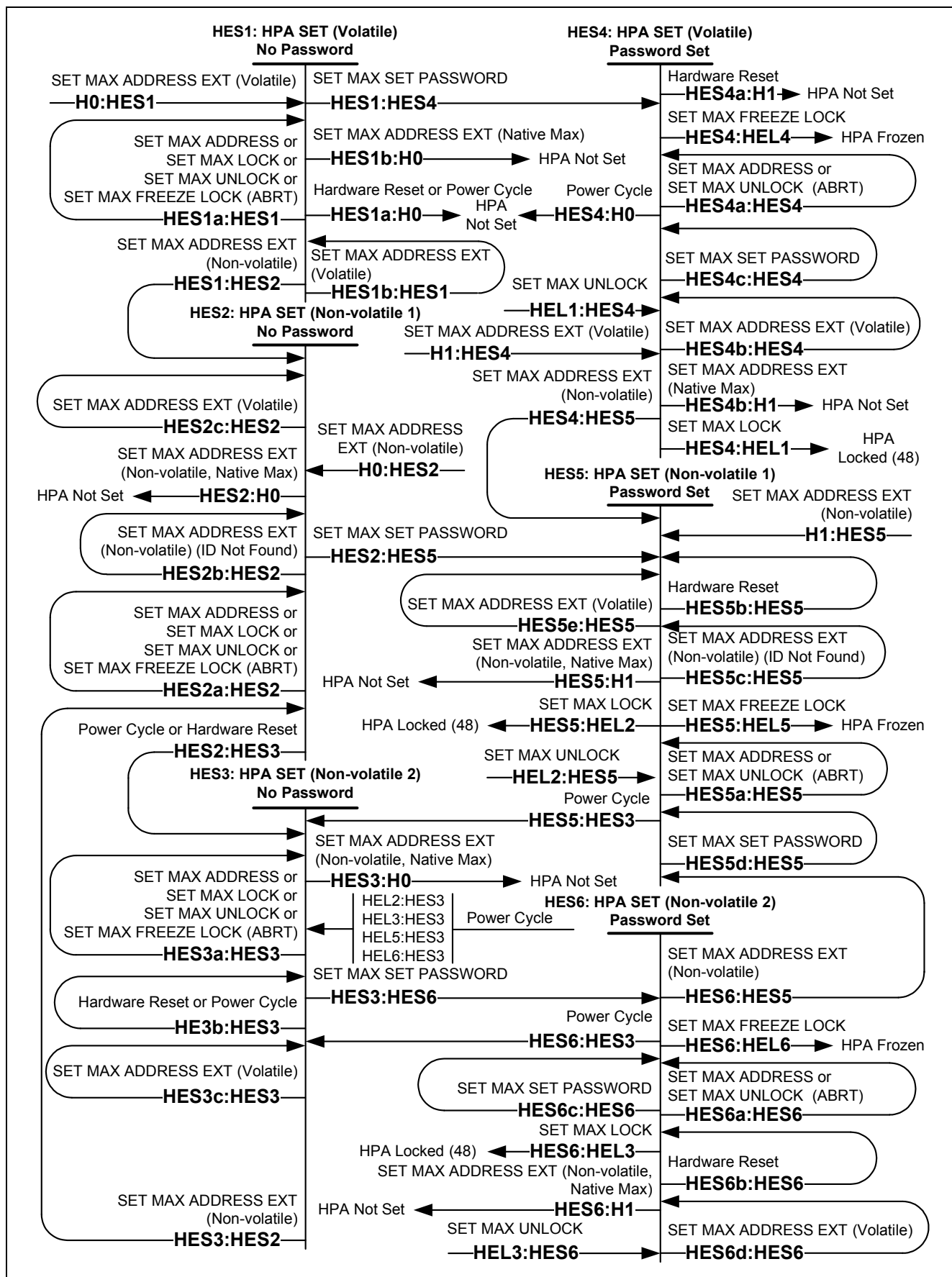
Figure 7 — HPA Set (48)
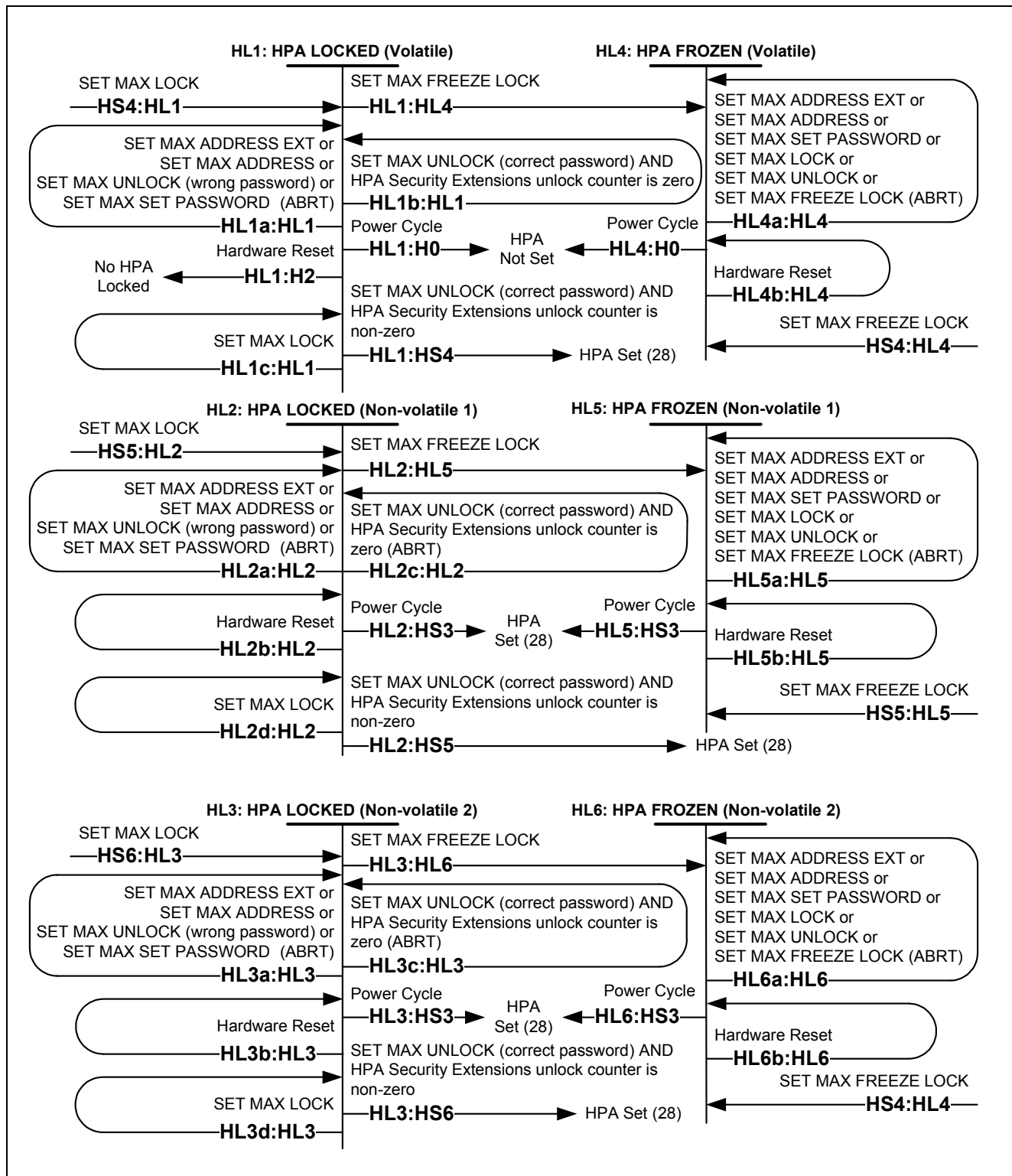
Figure 8 — HPA Locked (28)
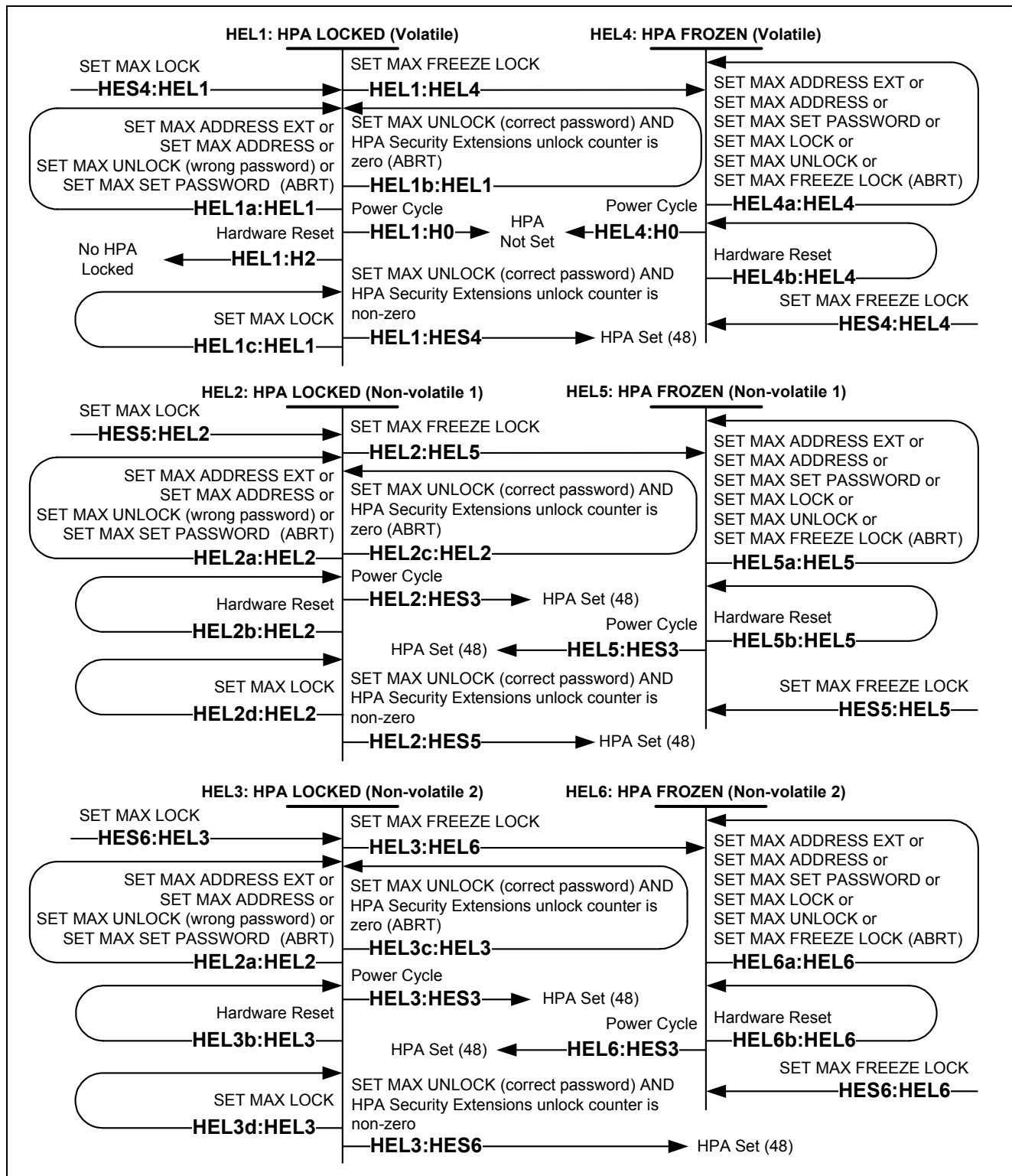
Figure 9 — HPA Locked (48)

4.12.6.2 HPA Not Set

State H0: No HPA/No Password: This state shall be entered when the device is powered on and does not have a non-volatile max address set . In this state the device has not established the HPA and the password has not been set.

Transition H0:H1: When the device successfully processes a SET MAX SET PASSWORD () without error, the device shall transition to the H1 state.

Transition H0:HS1: When the device successfully processes a SET MAX ADDRESS (Volatile) without error, the device shall process the command and transition to the HS1 state.

Transition H0:HS2: When the device successfully processes a First SET MAX ADDRESS (non-volatile) without error, the device shall process the command and transition to the HS2 state . A First SET MAX ADDRESS (non-volatile) is the first SET MAX ADDRESS (non-volatile) processed by the device after a power cycle.

Transition H0:HES1: When the device successfully processes a SET MAX ADDRESS EXT (Volatile) without error, the device shall process the command and transition to the HES1 state.

Transition H0:HES2: When the device successfully processes a SET MAX ADDRESS EXT (Non-Volatile) without error, the device shall process the command and transition to the HES2 state.

Transition H0a:H0: When the device successfully processes a SET MAX LOCK (), SET MAX UNLOCK (), SET MAX FREEZE LOCK (), additional SET MAX ADDRESS EXT (non-volatile), or an additional SET MAX ADDRESS (non-volatile) without error, the device shall return command aborted and remain in the same state . An additional SET MAX ADDRESS (non-volatile) is a SET MAX ADDRESS (non-volatile) that is processed by the device after a previous SET MAX ADDRESS (non-volatile)) has been successfully processed by the device with no intervening power cycle.

Transition H0b:H0: When the device successfully processes a SET MAX ADDRESS (Native Max) or SET MAX ADDRESS EXT (Native Max) without error, the device shall remain in the same state.

Transition H0c:H0: When the device successfully processes a hardware reset or a power cycle, the device shall remain in the same state.

State H1: No HPA/Password Set: In this state the device has not established the HPA and the password has been set.

Transition H1:H0: When the device successfully processes a power cycle, the device shall transition to the H0 state.

Transition H1:H2: When the device successfully processes a SET MAX LOCK (), the device shall transition to the H2 state.

Transition H1:H3: When the device successfully processes a SET MAX FREEZE LOCK () without error, the device shall transition to the H3 state.

Transition H1:HS4: When the device successfully processes a SET MAX ADDRESS (Volatile), the device shall transition to the HS4 state.

Transition H1:HES4: When the device successfully processes a SET MAX ADDRESS EXT (Volatile), the device shall transition to the HES4 state.

Transition H1:HES5: When the device successfully processes a First SET MAX ADDRESS EXT (Non-Volatile), the device shall transition to the HES5 state . A First SET MAX ADDRESS EXT (Non-volatile) is the first SET MAX ADDRESS (non-volatile) processed by the device after a power cycle

Transition H1a:H1: When the device successfully processes a SET MAX UNLOCK (), the device shall report command aborted and remain in the same state.

Transition H1b:H1: When the device successfully processes a SET MAX ADDRESS (Native Max) or SET MAX ADDRESS EXT (Native Max) without error, the device shall remain in the same state.

Transition H1c:H1: When the device successfully processes a SET MAX SET PASSWORD () without error, the device shall remain in the same state.

Transition H1d:H1: If the device processes a hardware reset, the device shall remain in the same state.

Transition H1e:H1: When the device successfully processes an additional
SET MAX ADDRESS EXT (Non-volatile) or an additional SET MAX ADDRESS (Non-volatile), the device shall return command aborted and remain in the same state . An "additional SET MAX ADDRESS (Non-volatile)" is a SET MAX ADDRESS (Non-volatile) that is processed by the device after a previous SET MAX ADDRESS (Non-volatile) has been successfully processed by the device with no intervening power cycle.

State H2: No HPA/Locked: In this state the device is HPA Locked and only the power cycle transits the state to the H0 state.

Transition H2:H0: When the device successfully processes a power cycle, the device shall transition to the H0 state.

Transition H2:H1: When the device successfully processes a SET MAX UNLOCK () with the correct password, the device shall transition to the H1 state.

Transition H2:H3: When the device successfully processes a SET MAX FREEZE LOCK () with the correct password, the device shall transition to the H3 state.

Transition H2a:H2: When the device successfully processes a SET MAX ADDRESS EXT (),
SET MAX ADDRESS (), or SET MAX SET PASSWORD (), the device shall return command aborted and remain in the same state.

Transition H2b:H2: If the device processes a hardware reset, then the device shall remain in the same state.

Transition H2c:H2: If the device successfully processes a SET MAX LOCK (), the device shall remain in the same state and the device may return command aborted.

State H3: No HPA FROZEN: In this state no HPA is established and the device is locked from all HPA commands . Only a power cycle shall cause the device to change to another state.

Transition H3:H0: When the device successfully processes a power cycle, the device shall transition to the H0 state.

Transition H3a:H3: When the device successfully processes a SET MAX ADDRESS EXT (),
SET MAX ADDRESS (), SET MAX LOCK (), SET MAX UNLOCK (), SET MAX FREEZE LOCK () or
SET MAX SET PASSWORD), the device shall return command aborted and remain in the same state.

Transition H3b:H3: When the device processes a hardware reset, the device shall remain in the same state.

4.12.6.3 28-bit HPA Set

State HS1: HPA SET (Volatile)/No Password: In this state the volatile 28-bit HPA is established and the password is not set.

Transition HS1:HS2: When the device successfully processes a SET MAX ADDRESS () without error in non-volatile state, the device shall transition to the HS2 state.

Transition HS1:HS4: When the device successfully processes a SET MAX SET PASSWORD () without error, the device shall transition to the HS4 state.

Transition HS1a:H0: When the device successfully processes a hardware reset or if device processes a power cycle, the device shall transition to the H0 state.

Transition HS1b:H0: When the device successfully processes a SET MAX ADDRESS (Native Max) without error, the device shall transition to the H0 state.

Transition HS1a:HS1: When the device successfully processes a SET MAX ADDRESS EXT (),
SET MAX LOCK (), SET MAX UNLOCK (), or SET MAX FREEZE LOCK (), the device shall return command aborted and remain in the same state.

Transition HS1b:HS1: When the device successfully processes a SET MAX ADDRESS (Volatile), the device shall remain in the same state.

State HS2: HPA SET (Non-Volatile 1)/No Password: In this state the non-volatile 28-bit HPA is established and the password is not set.

Transition HS2:H0: When the device successfully processes a SET MAX ADDRESS (Non-Volatile, Native Max), the device shall transition to the H0 state.

Transition HS2:HS5: When the device successfully processes a SET MAX SET PASSWORD (), the device shall transition to the HS5 state.

Transition HS2a:HS2: When the device successfully processes a SET MAX ADDRESS EXT (), SET MAX LOCK (), SET MAX UNLOCK () or SET MAX FREEZE LOCK (), the device shall return command aborted and remain in the same state.

Transition HS2b:HS2: When the device successfully processes a SET MAX ADDRESS (Non-Volatile), the device shall return ID Not Found and remain in the same state.

Transition HS2c:HS2: When the device successfully processes a SET MAX ADDRESS (Volatile), the device shall remain in the same state.

Transition HS2:HS3: When the device successfully processes a power cycle or a hardware reset, the device shall make transition to the HS3 state.

State HS3: HPA SET (Non-Volatile 2)/No Password: In this state the non-volatile 28-bit HPA is established and the password is not set.

Transition HS3:H0: When the device successfully processes a SET MAX ADDRESS (Non-Volatile, Native Max), the device shall transition to the H0 state.

Transition HS3:HS2: When the device successfully processes a SET MAX ADDRESS (Non-Volatile) without error, the device shall transition to the HS2 state.

Transition HS3:HS6: When the device successfully processes a SET MAX SET PASSWORD () without error, the device shall transition to the HS6 state.

Transition HS3a:HS3: When the device successfully processes a SET MAX ADDRESS EXT (), SET MAX LOCK (), SET MAX UNLOCK () or SET MAX FREEZE LOCK (), the device shall return command aborted and remain in the same state.

Transition HS3b:HS3: When the device successfully processes a hardware reset or when the device successfully processes a power cycle, the device shall remain in the same state.

Transition HS3c:HS3: When the device successfully processes a SET MAX ADDRESS (Volatile) without error, the device shall remain in the same state.

State HS4: HPA SET (Volatile)/Password Set: In this state the volatile 28-bit HPA is established and the password is set.

Transition HS4:HL1: When the device successfully processes a SET MAX LOCK (), the device shall transition to the HL1 state.

Transition HS4:HL4: When the device successfully processes a SET MAX FREEZE LOCK (), the device shall transition to the HL4 state.

Transition HS4:H0: When the device successfully processes a power cycle, the device shall transition to the H0 state.

Transition HS4:HS5: When the device successfully processes a SET MAX ADDRESS (Non-Volatile), the device shall process the command and transition to the HS5 state.

Transition HS4a:H1: When the device processes a hardware reset, the device shall transition to the H1 state.

Transition HS4b:H1: When the device successfully processes a SET MAX ADDRESS (Native Max) without error, the device shall transition to the H1 state.

Transition HS4a:HS4: When the device successfully processes a SET MAX ADDRESS EXT () or SET MAX UNLOCK (), the device shall return command aborted and remain in the same state.

Transition HS4b:HS4: When the device successfully processes a SET MAX ADDRESS (Volatile), the device shall remain in the same state.

Transition HS4c:HS4: When the device successfully processes a SET MAX SET PASSWORD (), the device shall remain in the same state.

State HS5: HPA SET (Non-Volatile 1)/Password Set: In this state the non-volatile 28-bit HPA is established and the password is set.

Transition H1:HS5: When the device successfully processes a SET MAX ADDRESS (Non-Volatile), the device shall transition to the HS5 state.

Transition HS5:H1: When the device successfully processes a SET MAX ADDRESS (Native Max), the device shall transition to the H1 state.

Transition HS5:HL2: When the device successfully processes a SET MAX LOCK (), the device shall transition to the HL2 state.

Transition HS5:HL5: When the device successfully processes a SET MAX FREEZE LOCK (), the device shall transition to the HL5 state.

Transition HS5:HS3: When the device successfully processes a power cycle, the device shall transition to the HS3 state.

Transition HS5a:HS5: When the device successfully processes a SET MAX ADDRESS EXT () or SET MAX UNLOCK (), the device shall return command aborted and remain in the same state.

Transition HS5b:HS5: When the device successfully processes a hardware reset, the device shall remain in the same state.

Transition HS5c:HS5: When the device successfully processes a SET MAX ADDRESS (Non-Volatile), the device shall return command ID Not Found and remain in the same state.

Transition HS5d:HS5: When the device successfully processes a SET MAX SET PASSWORD (), the device shall remain in the same state.

Transition HS5e:HS5: When the device successfully processes a SET MAX ADDRESS (Volatile), the device shall remain in the same state.

State HS6: HPA SET (Non-Volatile 2)/Password Set: In this state the non-volatile 28-bit HPA is established and the password is set.

Transition HS6:HS5: When the device successfully processes a SET MAX ADDRESS (Non-volatile), the device shall transition to the HS5 state.

Transition HS6:H1: When the device successfully processes a SET MAX ADDRESS (Non-volatile, Native Max), the device shall transition to the H1 state.

Transition HS6:HL3: When the device successfully processes a SET MAX LOCK (), the device shall transition to the HL3 state.

Transition HS6:HL6: When the device successfully processes a SET MAX FREEZE LOCK (), the device shall transition to the HL6 state.

Transition HS6:HS3: When the device successfully processes a power cycle, the device shall transition to the HS3 state.

Transition HS6a:HS6: When the device successfully processes a SET MAX ADDRESS EXT () or SET MAX UNLOCK (), the device shall return command aborted and remain in the same state.

Transition HS6b:HS6: When the device successfully processes a hardware reset, the device shall remain in the same state.

Transition HS6c:HS6: When the device successfully processes a SET MAX SET PASSWORD (), the device shall remain in the same state.

Transition HS6d:HS6: When the device successfully processes a SET MAX ADDRESS (Volatile), the device shall remain in the same state.

4.12.6.4 48-Bit HPA Set

State HES1: HPA SET (Volatile)/No Password: In this state the volatile 48-bit HPA is established and the password is not set.

Transition HES1:HES2: When the device successfully processes a SET MAX ADDRESS EXT (Non-Volatile), the device shall transition to the HES2 state.

Transition HES1:HES4: When the device successfully processes a SET MAX SET PASSWORD (), the device shall transition to the HES4 state.

Transition HES1a:H0: When the device successfully processes a hardware reset or if the device successfully processes a power cycle, the device shall transition to the H0 state.

Transition HES1b:H0: When the device successfully processes a SET MAX ADDRESS (Native Max), the device shall transition to the H0 state.

Transition HES1a:HES1: When the device successfully processes a SET MAX ADDRESS (), SET MAX LOCK (), SET MAX UNLOCK () or SET MAX FREEZE LOCK (), the device shall return command aborted and remain in the same state.

Transition HES1b:HES1: When the device successfully processes a SET MAX ADDRESS EXT (Volatile), the device shall remain in the same state.

State HES2: HPA SET (Non-Volatile 1)/No Password: In this state the non-volatile 48-bit HPA is established and the password is not set.

Transition HES2:H0: When the device successfully processes a SET MAX ADDRESS EXT (Non-Volatile, Native Max), the device shall transition to the H0 state.

Transition HES2:HES3: When the device successfully processes a power cycle or a hardware reset, the device shall transition to the HES3 state.

Transition HES2:HES5: When the device successfully processes a SET MAX SET PASSWORD (), the device shall transition to the HES5 state.

Transition HES2a:HES2: When the device successfully processes a SET MAX ADDRESS (), SET MAX LOCK (), SET MAX UNLOCK () or SET MAX FREEZE LOCK (), the device shall return command aborted and remain in the same state.

Transition HES2b:HES2: When the device successfully processes a SET MAX ADDRESS EXT (Non-Volatile), the device shall return ID Not Found and remain in the same state.

Transition HES2c:HES2: When the device successfully processes a SET MAX ADDRESS EXT (Volatile), the device shall remain in the same state.

State HES3: HPA SET (Non-Volatile 2)/No Password: In this state the non-volatile 48-bit HPA is established and the password is not set.

Transition HES3:H0: When the device successfully processes a SET MAX ADDRESS EXT (Non-Volatile, Native Max), the device shall transition to the H0 state.

Transition HES3:HES2: When the device successfully processes a SET MAX ADDRESS EXT (Non-Volatile), the device shall transition to the HES2 state.

Transition HES3:HES6: When the device successfully processes a SET MAX SET PASSWORD (), the device shall transition to the HES6 state.

Transition HES3a:HES3: When the device successfully processes a SET MAX ADDRESS EXT (), SET MAX LOCK (), SET MAX UNLOCK () or SET MAX FREEZE LOCK (), the device shall return command aborted and remain in the same state.

Transition HES3b:HES3: When the device successfully processes a hardware reset or when the device successfully processes a power cycle, the device shall remain in the same state.

Transition HES3c:HES3: When the device processes a SET MAX ADDRESS EXT (Volatile) without error, the device shall remain in the same state..

State HES4: HPA SET (Volatile)/Password Set: In this state the volatile 48-bit HPA is established and the password is set.

Transition HES4:H0: When the device successfully processes a power cycle, the device shall transition to the H0 state.

Transition HES4:HES5: When the device successfully processes a SET MAX ADDRESS EXT (Non-Volatile), the device shall transition to the HES5 state.

Transition HES4:HEL1: When the device successfully processes a SET MAX LOCK (), the device shall transition to the HEL1 state.

Transition HES4a:H1: When the device processes a hardware reset, the device shall transition to the H1 state.

Transition HES4b:H1: When the device successfully processes a SET MAX ADDRESS (Native Max), the device shall transition to the H1 state.

Transition HES4:HEL4: When the device successfully processes a SET MAX FREEZE LOCK (), the device shall transition to the HEL4 state.

Transition HES4a:HES4: When the device successfully processes a SET MAX ADDRESS () or SET MAX UNLOCK (), the device shall return command aborted and remain in the same state.

Transition HES4b:HES4: When the device successfully processes a SET MAX ADDRESS EXT (Volatile), the device shall remain in the same state.

Transition HES4c:HES4: When the device successfully processes a SET MAX SET PASSWORD (), the device shall remain in the same state.

State HES5: HPA SET (Non-Volatile 1)/Password Set: In this state the non-volatile 48-bit HPA is established and the password is set.

Transition HES5:H1: When the device successfully processes a SET MAX ADDRESS EXT (Non-volatile, Native Max), the device shall transition to the H1 state.

Transition HES5:HEL2: When the device successfully processes a SET MAX LOCK (), the device shall transition to the HEL2 state.

Transition HES5:HES3: When the device successfully processes a power cycle, the device shall transition to the HES3 state.

Transition HES5:HEL5: When the device successfully processes a SET MAX FREEZE LOCK (), the device shall transition to the HEL5 state.

Transition HES5a:HES5: When the device successfully processes a SET MAX ADDRESS () or SET MAX UNLOCK (), the device shall return command aborted and remain in the same state.

Transition HES5b:HES5: When the device successfully processes a hardware reset, the device shall remain in the same state.

Transition HES5c:HES5: When the device successfully processes a SET MAX ADDRESS EXT (Non-Volatile), the device shall return ID Not Found and remain in the same state.

Transition HES5d:HES5: When the device successfully processes a SET MAX SET PASSWORD (), the device shall remain in the same state.

Transition HES5e:HES5: When the device successfully processes a SET MAX ADDRESS EXT (Volatile), the device shall remain in the same state.

State HES6: HPA SET (Non-Volatile 2)/Password Set: In this state the non-volatile 48-bit HPA is established and the password is set.

Transition HES6:HES5: When the device successfully processes a SET MAX ADDRESS EXT (Non-Volatile), the device shall transition to the HES5 state.

Transition HES6:H1: When the device successfully processes a SET MAX ADDRESS EXT (Non-Volatile, Native Max), the device shall transition to the H1 state.

Transition HES6:HEL3: When the device successfully processes a SET MAX LOCK (), the device shall transition to the HEL3 state.

Transition HES6:HES3: When the device successfully processes a power cycle, the device shall transition to the HES3 state.

Transition HES6:HEL6: When the device successfully processes a SET MAX FREEZE LOCK (), the device shall transition to the HEL6 state.

Transition HES6a:HES6: When the device successfully processes a SET MAX ADDRESS () or SET MAX UNLOCK (), the device shall return command aborted and remain in the same state.

Transition HES6b:HES6: When the device successfully processes a hardware reset, the device shall remain in the same state.

Transition HES6c:HES6: When the device successfully processes a SET MAX SET PASSWORD (), the device shall remain in the same state .

Transition HES6d:HES6: When the device successfully processes a SET MAX ADDRESS EXT (Volatile), the device shall remain in the same state.

4.12.6.5 28-Bit HPA Locked

State HL1: HPA LOCKED (Volatile): In this state the volatile 28-bit HPA is established, and the device is locked from HPA commands, except SET MAX UNLOCK (), with a proper password or SET MAX FREEZE LOCK ().

Transition HL1:H0: When the device successfully processes a power cycle, the device shall transition to the H0 state.

Transition HL1:HL4: When the device successfully processes a SET MAX FREEZE LOCK (), the device shall transition to the HL4 state.

Transition HL1:HS4: When the device successfully processes a SET MAX UNLOCK (correct password), and the HPA Security Extensions unlock counter is non-zero, the device shall transition to the HS4 state.

Transition HL1:H2: When the device successfully processes a hardware reset, the device shall transition to the H2 state.

Transition HL1a:HL1: When the device successfully processes a SET MAX ADDRESS EXT (), SET MAX ADDRESS (), SET MAX UNLOCK (wrong password) or SET MAX SET PASSWORD (), the device shall return command aborted and remain in the same state.

Transition HL1b:HL1: When the device successfully processes a SET MAX UNLOCK (correct password) and the HPA Security Extensions unlock counter is zero, the device shall return command aborted and remain in the same state.

Transition HL1c:HL1: If the device successfully processes a SET MAX LOCK (), the device shall remain in the same state and the device may return command aborted.

State HL2: HPA LOCKED (Non-volatile 1): In this state the non-volatile 28-bit HPA is established, and the device is locked from HPA commands except SET MAX UNLOCK () with a proper password or SET MAX FREEZE LOCK ().

Transition HL2:HL5: When the device successfully processes a SET MAX FREEZE LOCK (), the device shall transition to the HL5 state .

Transition HL2:HS3: When the device successfully processes a power cycle, the device shall transition to the HS3 state.

Transition HL2:HS5: When the device successfully processes a SET MAX UNLOCK (correct password) and the HPA Security Extensions unlock counter is non-zero, the device shall transition to the HS5 state.

Transition HL2a:HL2: When the device successfully processes a SET MAX ADDRESS EXT (), SET MAX ADDRESS (), SET MAX UNLOCK (wrong password) or SET MAX SET PASSWORD (), the device shall return command aborted and remain in the same state.

Transition HL2b:HL2: When the device successfully processes a hardware reset, the device shall remain in the same state.

Transition HL2c:HL2: When the device successfully processes a SET MAX UNLOCK (correct password) and the HPA Security Extensions unlock counter is zero, the device shall return command aborted and remain in the same state..

Transition HL2d:HL2: If the device successfully processes a SET MAX LOCK (), the device shall remain in the same state and the device may return command aborted.

State HL3: HPA LOCKED (Non-volatile 2): In this state a non-volatile 28-bit HPA is established, and the device is locked from HPA commands except a SET MAX UNLOCK () with a proper password or a SET MAX FREEZE LOCK ().

Transition HL3:HL6: When the device successfully processes a SET MAX FREEZE LOCK (), the device shall transition to the HL6 state.

Transition HL3:HS3: When the device successfully processes a power cycle, the device shall transition to the HS3 state.

Transition HL3:HS6: When the device successfully processes a SET MAX UNLOCK () without error with the correct password and the HPA Security Extensions unlock counter is non-zero, the device shall transition to the HS6 state.

Transition HL3a:HL3: When the device successfully processes a SET MAX ADDRESS EXT (),
SET MAX ADDRESS (), SET MAX UNLOCK (wrong password) or SET MAX SET PASSWORD (), the device shall return command aborted and remain in the same state . If a SET MAX UNLOCK (wrong password) is successfully processes the HPA Security Extensions unlock counter shall be decremented by one.

Transition HL3b:HL3: When the device successfully processes a hardware reset, the device shall remain in the same state .

Transition HL3c:HL3: When the device successfully processes a SET MAX UNLOCK (correct password) and the HPA Security Extensions unlock counter is zero, the device shall return command aborted and remain in the same state.

Transition HL3d:HL3: If the device successfully processes a SET MAX LOCK (), the device shall remain in the same state and the device may return command aborted.

State HL4: HPA FROZEN (Volatile): In this state a volatile 28-bit HPA is established and the device is locked from all HPA commands.

Transition HL4:H0: When the device successfully processes a power cycle, the device shall transition to the H0 state.

Transition HL4a:HL4: When the device successfully processes a SET MAX ADDRESS EXT (),
SET MAX ADDRESS (), SET MAX LOCK (), SET MAX UNLOCK (), SET MAX FREEZE LOCK () or
SET MAX SET PASSWORD (), the device shall return command aborted and remain in the same state.

Transition HL4b:HL4: When the device processes a hardware reset, the device shall remain in the same state.

State HL5: HPA FROZEN (Non-Volatile 1): In this state the non-volatile 28-bit HPA is established and the device is locked from all HPA commands.

Transition HL5a:HL5: When the device successfully processes a SET MAX ADDRESS EXT (),
SET MAX ADDRESS (), SET MAX LOCK (), SET MAX UNLOCK (), SET MAX FREEZE LOCK () or
SET MAX SET PASSWORD (), the device shall return command aborted and remain in the same state.

Transition HL5b:HL5: When the device successfully processes a hardware reset, the device shall remain in the same state.

Transition HL5:HS3: When the device successfully processes a power cycle, the device shall transition to the HS3 state .

State HL6: HPA FROZEN (Non-Volatile 2): In this state the non-volatile 28-bit HPA is established and the device is locked from all HPA commands.

Transition HL6:HS3: When the device successfully processes a power cycle, the device shall transition to the HS3 state.

Transition HL6a:HL6: When the device successfully processes a SET MAX ADDRESS EXT (),
SET MAX ADDRESS (), SET MAX LOCK (), SET MAX UNLOCK (), SET MAX FREEZE LOCK () or
SET MAX SET PASSWORD (), the device shall return command aborted and remain in the same state.

Transition HL6b:HL6: When the device successfully processes a hardware reset, the device shall remain in the same state.

4.12.6.6 48-Bit HPA Locked

State HEL1: HPA LOCKED (Volatile): In this state a volatile 48-bit HPA is established, and the device is locked from HPA commands, except a SET MAX UNLOCK (), with a proper password or a SET MAX FREEZE LOCK ().

Transition HEL1:H0: When the device processes a power cycle, the device shall transition to the H0 state.

Transition HEL1:H2: When the device successfully processes a hardware reset, the device shall transition to the H2 state.

Transition HEL1:HEL4: When the device successfully processes a SET MAX FREEZE LOCK (), the device shall transition to the HEL4 state.

Transition HEL1:HES4: When the device successfully processes a SET MAX UNLOCK (correct password) and the HPA Security Extensions unlock counter is non-zero; the device shall transition to the HES4 state.

Transition HEL1a:HEL1: When the device successfully processes a SET MAX ADDRESS (),
SET MAX ADDRESS EXT (), SET MAX UNLOCK (wrong password) or SET MAX SET PASSWORD (), the device shall return command aborted and remain in the same state.

Transition HEL1b:HEL1: When the device successfully processes a SET MAX UNLOCK (correct password) and the HPA Security Extensions unlock counter is zero, the device shall return command aborted and remain in the same state.

Transition HEL1c:HEL1: If the device successfully processes a SET MAX LOCK (), the device shall remain in the same state and the device may return command aborted.

State HEL2: HPA LOCKED (Non-volatile 1): In this state a non-volatile 48-bit HPA is established, and the device is locked from HPA commands, except a SET MAX UNLOCK (), with a proper password or a SET MAX FREEZE LOCK ().

Transition HES5:HEL2: When the device successfully processes a SET MAX LOCK (), the device shall transition to the HEL2 state.

Transition HEL2:HEL5: When the device successfully processes a SET MAX FREEZE LOCK (), the device shall transition to the HEL5 state.

Transition HEL2:HES3: When the device successfully processes a power cycle, the device shall transition to the HES3 state.

Transition HEL2:HES5: When the device successfully processes a SET MAX UNLOCK (correct password) and the HPA Security Extensions unlock counter is non-zero, the device shall transition to the HES5 state.

Transition HEL2a:HEL2: When the device successfully processes a SET MAX ADDRESS (),
SET MAX ADDRESS EXT (), SET MAX UNLOCK (wrong password) or SET MAX SET PASSWORD (), the device shall return command aborted and remain in the same state.

Transition HEL2b:HEL2: When the device successfully processes a hardware reset, the device shall transition to the HEL2 state.

Transition HEL2c:HEL2: When the device successfully processes a SET MAX UNLOCK (correct password) and the HPA Security Extensions unlock counter is zero, the device shall return command aborted and remain in the same state.

Transition HEL2d:HEL2: If the device successfully processes a SET MAX LOCK (), the device shall remain in the same state and the device may return command aborted.

State HEL3: HPA LOCKED (Non-volatile 2): In this state a non-volatile 48-bit HPA is established, and the device is locked from HPA commands, except a SET MAX UNLOCK (), with a proper password or a SET MAX FREEZE LOCK ().

Transition HEL3:HEL6: When the device successfully processes a SET MAX FREEZE LOCK (), the device shall transition to the HEL6 state.

Transition HEL3:HES3: When the device successfully processes a power cycle, the device shall transition to the HES3 state.

Transition HEL3:HES6: When the device successfully processes a SET MAX UNLOCK () with the correct password and the HPA Security Extensions unlock counter is non-zero, the device shall transition to the HES6 state.

Transition HEL3a:HEL3: When the device successfully processes a SET MAX ADDRESS (), SET MAX ADDRESS EXT (), SET MAX UNLOCK (wrong password) or SET MAX SET PASSWORD (), the device shall return command aborted and remain in the same state . If a SET MAX UNLOCK (wrong password) is received the HPA Security Extensions unlock counter shall be decremented by one.

Transition HEL3b:HEL3: When the device successfully processes a hardware reset, the device shall remain in the same state.

Transition HEL3c:HEL3: When the device successfully processes a SET MAX UNLOCK (correct password) and the HPA Security Extensions unlock counter is zero, the device shall return command aborted and remain in the same state.

Transition HEL3d:HEL3: If the device successfully processes a SET MAX LOCK (), the device shall remain in the same state and the device may return command aborted.

State HEL4: HPA FROZEN (Volatile): In this state the volatile 48-bit HPA is established and the device is locked from all HPA commands.

Transition HEL4:H0: When the device successfully processes a power cycle, the device shall transition to the H0 state.

Transition HEL4a:HEL4: When the device successfully processes a SET MAX ADDRESS (), SET MAX ADDRESS EXT (), SET MAX LOCK (), SET MAX UNLOCK (), SET MAX FREEZE LOCK () or SET MAX SET PASSWORD (), the device shall return command aborted and remain in the same state.

Transition HEL4b:HEL4: When the device successfully processes a hardware reset, the device shall remain in the same state.

HEL5: HPA FROZEN (Non-Volatile 1): In this state the non-volatile 48-bit HPA is established, and the device is locked from all HPA commands.

Transition HEL5a:HEL5: When the device successfully processes a SET MAX ADDRESS (), SET MAX ADDRESS EXT (), SET MAX LOCK (), SET MAX UNLOCK (), SET MAX FREEZE LOCK () or SET MAX SET PASSWORD (), the device shall return command aborted and remain in the same state.

Transition HEL5b:HEL5: When the device successfully processes a hardware reset, the device shall remain in the same state.

Transition HEL5:HES3: When the device successfully processes a power cycle, the device shall transition to the HES3 state.

State HEL6: HPA FROZEN (Non-Volatile 2): In this state a non-volatile 48-bit HPA is established, and the device is locked from all HPA commands.

Transition HEL6:HES3: When the device successfully processes a power cycle, the device shall transition to the HES3 state.

Transition HEL6a:HEL6: When the device successfully processes a SET MAX ADDRESS (), SET MAX ADDRESS EXT (), SET MAX LOCK (), SET MAX UNLOCK (), SET MAX FREEZE LOCK () or SET MAX SET PASSWORD (), the device shall return command aborted and remain in the same state.

Transition HEL6b:HEL6: When the device successfully processes a hardware reset, the device shall remain in the same state.

4.13 Long Logical Sector (LLS) feature set

The Long Logical Sector (LLS) feature set provides a method for a device to indicate that it has more than 256 words per logical sector (e.g., sectors with 520 or 528 bytes) . Devices with logical sectors longer than 256 words shall set IDENTIFY DEVICE data word 106 bit 12 to 1 (see 7.18.7.56) . The logical sector size is described by IDENTIFY DEVICE data words 117..118 (see 7.18.7.61).

Table 7 describes the command behavior of ATA devices that support the LLS feature set . Data transfer commands transfer either the long logical sector length or 256 words depending on the command (e.g., the READ DMA EXT command and the WRITE DMA EXT command transfer data in long logical sectors while the READ LOG EXT command and the WRITE LOG EXT command transfer 256 word blocks of data, regardless of the logical sector length) . Figure 10 example 2 shows a diagram of a device formatted with long logical sectors.

The Long Physical Sector (LPS) feature set (see 4.14) and the LLS feature set are not mutually exclusive . Figure 10 example 4 illustrates a device implementing both the LPS and LLS feature sets.

Table 7 — Block Size By Command (part 1 of 2)

Command	Words transferred per block
ADD LBA(S) TO NV CACHE PINNED SET	256
CFA TRANSLATE SECTOR	IDENTIFY DEVICE data words (118:117)
CFA WRITE MULTIPLE WITHOUT ERASE	IDENTIFY DEVICE data words (118:117)
CFA WRITE SECTORS WITHOUT ERASE	IDENTIFY DEVICE data words (118:117)
DATA SET MANAGEMENT	256
DEVICE CONFIGURATION IDENTIFY	256
DEVICE CONFIGURATION IDENTIFY DMA	256
DEVICE CONFIGURATION SET	256
DEVICE CONFIGURATION SET DMA	256
DOWNLOAD MICROCODE	256
DOWNLOAD MICROCODE DMA	256
IDENTIFY DEVICE	256
IDENTIFY PACKET DEVICE	256
QUERY NV CACHE MISSES	256
QUERY NV CACHE PINNED SET	256
REMOVE LBA(S) FROM NV CACHE PINNED SET	256
READ BUFFER	256
READ BUFFER DMA	256
READ DMA	IDENTIFY DEVICE data words (118:117)
READ DMA EXT	IDENTIFY DEVICE data words (118:117)
READ FPDMA QUEUED	IDENTIFY DEVICE data words (118:117)
READ LOG EXT	256
READ LOG DMA EXT	256
READ MULTIPLE	IDENTIFY DEVICE data words (118:117)
READ MULTIPLE EXT	IDENTIFY DEVICE data words (118:117)
READ SECTOR(S)	IDENTIFY DEVICE data words (118:117)
READ SECTOR(S) EXT	IDENTIFY DEVICE data words (118:117)
READ STREAM DMA EXT	IDENTIFY DEVICE data words (118:117)
READ STREAM EXT	IDENTIFY DEVICE data words (118:117)

Table 7 — Block Size By Command (part 2 of 2)

Command	Words transferred per block
READ VERIFY SECTOR(S)	IDENTIFY DEVICE data words (118:117)
SECURITY DISABLE PASSWORD	256
SECURITY ERASE UNIT	256
SECURITY SET PASSWORD	256
SECURITY UNLOCK	256
SET MAX SET PASSWORD	256
SET MAX SET PASSWORD DMA	256
SET MAX UNLOCK	256
SET MAX UNLOCK DMA	256
SMART READ DATA	256
SMART READ LOG	256
SMART WRITE LOG	256
TRUSTED RECEIVE	256
TRUSTED RECEIVE DMA	256
TRUSTED SEND	256
TRUSTED SEND DMA	256
WRITE BUFFER	256
WRITE BUFFER DMA	256
WRITE DMA	IDENTIFY DEVICE data words (118:117)
WRITE DMA EXT	IDENTIFY DEVICE data words (118:117)
WRITE DMA FUA EXT	IDENTIFY DEVICE data words (118:117)
WRITE FPDMA QUEUED	IDENTIFY DEVICE data words (118:117)
WRITE LOG EXT	256
WRITE LOG DMA EXT	256
WRITE MULTIPLE	IDENTIFY DEVICE data words (118:117)
WRITE MULTIPLE EXT	IDENTIFY DEVICE data words (118:117)
WRITE MULTIPLE FUA EXT	IDENTIFY DEVICE data words (118:117)
WRITE SECTOR(S)	IDENTIFY DEVICE data words (118:117)
WRITE SECTOR(S) EXT	IDENTIFY DEVICE data words (118:117)
WRITE STREAM DMA EXT	IDENTIFY DEVICE data words (118:117)
WRITE STREAM EXT	IDENTIFY DEVICE data words (118:117)

4.14 Long Physical Sector (LPS) feature set

The Long Physical Sector (LPS) feature set allows a device to indicate that there are multiple logical sectors per physical sector (see figure 10).

Long Physical Sector Alignment Error Reporting Control (see 7.50.18) and the LPS Mis-alignment log (see A.11) are optional for devices implementing the LPS feature set.

Conventional logical sector example: 512 bytes per LBA

◄–512 Bytes–►	◄–512 Bytes–►	◄–512 Bytes–►	◄–512 Bytes–►	◄–512 Bytes–►	◄–512 Bytes–►	◄–512 Bytes–►	
LBA 0	LBA 1	LBA 2	LBA 3	LBA 4	LBA 5	LBA 6	...

Long logical sector example: 524 bytes per LBA

◄–524 Bytes–►	◄–524 Bytes–►	◄–524 Bytes–►	◄–524 Bytes–►	◄–524 Bytes–►	◄–524 Bytes–►	◄–524 Bytes–►	
LBA 0	LBA 1	LBA 2	LBA 3	LBA 4	LBA 5	LBA 6	...

Long physical sector example: 512 bytes per LBA, 1,024 bytes per physical sector

◄–512 Bytes–►	◄–512 Bytes–►	◄–512 Bytes–►	◄–512 Bytes–►	◄–512 Bytes–►	◄–512 Bytes–►	◄–512 Bytes–►	
LBA 0	LBA 1	LBA 2	LBA 3	LBA 4	LBA 5	LBA 6	...
Physical Sector 0		Physical Sector 1		Physical Sector 2		...	

Long logical and Long physical sector example: 524 bytes per LBA, 1,048 bytes per physical sector

◄–524 Bytes–►	◄–524 Bytes–►	◄–524 Bytes–►	◄–524 Bytes–►	◄–524 Bytes–►	◄–524 Bytes–►	◄–524 Bytes–►	
LBA 0	LBA 1	LBA 2	LBA 3	LBA 4	LBA 5	LBA 6	...
Physical Sector 0		Physical Sector 1		Physical Sector 2		...	

Figure 10 — LLS and LPS Example

If the device reports a LPS and a smaller logical sector, the device may report the alignment of the first logical sector (LBA 0) within the first physical sector . Example 1, example 2, and example 3 give examples of logical/physical sector alignments.

Example 1:

In Figure 11 there are 2 logical sectors within one physical sector, and the first logical sector is in the first half .

The offset is: 0, and the value in IDENTIFY DEVICE data word 209 is 4000h.

physical sector 0		**physical sector 1**	
logical sector 0	logical sector 1	logical sector 2	logical sector 3

Figure 11 — Alignment 0

Example 2:

In Figure 12 there are 2 logical sectors within one physical sector, and the first logical sector is in the second half . The offset is: 1, and the value in word 209 is 4001h.

physical sector 0		**physical sector 1**	
(inaccessible)	logical sector 0	logical sector 1	logical sector 2

Figure 12 — Alignment 1

Example 3:

In Figure 13 there are 4 logical sectors within one physical sector, and the first logical sector is in the second half . The offset is: 3, and the value in word 209 is 4003h.

physical sector 0				physical sector 1			
(inaccessible)	(inaccessible)	(inaccessible)	logical 0	logical 1	logical 2	logical 3	logical 4

Figure 13 — Alignment 3

4.15 Media Card Pass Through Command feature set

The Media Card Pass Through commands are implemented by a Media Pass Through device . A device implementing the Media Card Pass Through Command feature set is a bridge to one or more types of media card storage devices . The bridge device responds to the same command set as described in 4.2 and to the commands included in this feature set.

The Media Card Pass Through Command feature set uses the command codes D1h, D2h, D3h, and D4h and bits in IDENTIFY DEVICE data word 84 (see 7.18.7.40) and IDENTIFY DEVICE data word 87 (see 7.18.7.41) . The command codes D2h through D4h are reserved for the Media Card Pass Through Command feature set if this feature set is enabled by the CHECK MEDIA CARD TYPE command . This feature set embeds small-format flash memory card commands (see table 8) inside the ATA commands . The host adapter's firmware passes the embedded memory card's command to the memory card unmodified from the ATA command . The Media Card Pass Through Command feature set reduces the number of commands required for this feature set regardless of the number or type of memory card commands.

The following commands are mandatory for devices that implement the Media Card Pass Through Command feature set:

a) CHECK MEDIA CARD TYPE; and
b) Command codes D2h through D4h.

The CHECK MEDIA CARD TYPE command returns the supporting status of the device to this feature set . The CHECK MEDIA CARD TYPE command also enables and disables the device from running the Media Card Pass Through Command feature set . A device shall disable the Media Card Pass Through Command feature set during the processing of a power cycle, a hardware reset, or a software reset.

The definitions of the commands D2h-D4h are media card type dependent . Table 8 lists the Media card types and their associated reference document.

Table 8 — Media Card type references

Media Card Type	Reference Document
SD Card	SD Card ATA Command Extension (SDA 3C)

4.16 Native Command Queuing (NCQ) feature set

4.16.1 Overview

The NCQ feature set provides support for devices that implement the Serial Transport (see ATA8-AST) . The NCQ feature set allows commands within this feature set to be accepted even though the device has not reported command completion for one or more previously accepted commands in the NCQ feature set . A device reports command completion for commands in the NCQ feature set by returning a transport dependent indicator (see ATA8-AST) . The following commands are mandatory for devices implementing the NCQ feature set:

a) READ FPDMA QUEUED; and
b) WRITE FPDMA QUEUED.

Devices that report support for the NCQ feature set shall also report support for the GPL feature set (see 4.11), the General Purpose Log Directory log and the NCQ Command Error log.

If the device receives a command that is not an NCQ command while NCQ commands are in the queue, then the device shall return command aborted for the new command and for all of the NCQ commands that are in the queue.

All the commands in the NCQ feature set shall include a NCQ Tag . If the value of the NCQ Tag exceeds the value returned in IDENTIFY DEVICE data word 75 (see 7.18.7.33), then the device shall return command aborted for the new command and for all NCQ commands that are in the queue . If the device receives an NCQ command with a NCQ Tag value that is identical to the NCQ Tag value for another NCQ command in the queue, then the device shall return command aborted for the new command and for all the NCQ commands that are in the queue.

> NOTE 3 — The NCQ Tag identifies return information (i.e., error status, data transfer and command completion).

If an error occurs while the device is processing an NCQ command, then the device shall return command aborted for all NCQ commands that are in the queue and shall return command aborted for any new commands, except a READ LOG EXT command requesting log address 10h, until the device completes a READ LOG EXT command requesting log address 10h (i.e., reading the NCQ Command Error log) without error.

> NOTE 4 — The NCQ feature set uses 48-bit addresses and is intentionally not included in the 48-bit address feature set.

4.16.2 Priority

Host knowledge of I/O priority may be transmitted to the device as part of the command . There are two priority values for NCQ commands, normal and high . When the host marks an NCQ command as high priority, the host is requesting a better quality of service for that command than commands issued with normal priority.

The device may choose to complete a normal priority command before an outstanding high priority command, although preference should be given to the high priority commands . One example where a normal priority command may be completed before a high priority command is when the normal priority command is a cache hit, whereas the high priority command requires access of the device media.

The priority is specified in the PRIO bit for NCQ commands (i.e., the READ FPDMA QUEUED command and the WRITE FPDMA QUEUED command) . This bit may specify either the normal priority or high priority value . If a command is marked by the host as high priority, the device should attempt to provide better quality of service for the command . It is not required that devices process all high priority requests before satisfying normal priority requests.

4.16.3 Unload

When using Native Command Queuing, the host may request that a device which has movable read/write heads move them to a safe position.

When NCQ commands are outstanding, the device may accept the IDLE IMMEDIATE command with the Unload feature . Upon acceptance of this command with the Unload feature specified, the device shall:

1) move the heads to a safe position; and
2) return command aborted.

When the host receives the error indication, it should proceed to do a READ LOG EXT command for the NCQ Command Error log . In the log, the device shall indicate whether the error was due to accepting an IDLE IMMEDIATE command with the Unload feature and whether the Unload was processed . The device shall not load the heads to the media when processing the READ LOG EXT command for the NCQ Command Error log.

The READ LOG EXT command for the NCQ Command Error log indicates whether the device has accepted the Unload and if it is in the process of moving the heads to a safe position . For a indication of a successful Unload, the IDLE IMMEDIATE command with the Unload feature should be reissued after the READ LOG EXT command for the NCQ Command Error log is processed . After the READ LOG EXT command for the NCQ Command Error log is processed:

a) there are no NCQ commands outstanding; and
b) the NCQ error is cleared,

such that if the unload process completes successfully:

    a)   the IDLE IMMEDIATE command with the Unload Feature should be processed normally; and
    b)   a successful status should be returned.

There may be a delay in issuing the IDLE IMMEDIATE command with the Unload feature to the device if the device is currently performing a data transfer for a previously issued NCQ command.

4.16.4 Command Phases

4.16.4.1 Command Acceptance

The device receives a command in the NCQ feature set and returns command acceptance . Once the device reports command acceptance, it may then accept additional commands in the NCQ feature set.

4.16.4.2 Data transmission

Data transfer should occur after acceptance of the command.

4.16.4.3 Command completion

When the transfer of all of the data requested by one or more NCQ commands occurred without error, the device returns a transport dependent indicator (see ATA8-AST) that informs the host of completion for one or more NCQ commands.

If an error occurs while processing an NCQ command, then the device shall return command aborted for the command in error and for all other NCQ commands that are in the queue . The condition of the data for any NCQ command for which a device reports command aborted is indeterminate.

4.17 NV Cache feature set

4.17.1 Overview

The NV Cache is managed as two distinct areas, the NV Cache Pinned Set and the NV Cache Unpinned Set . Each LBA stored in the NV Cache Set has an attribute called the pinned attribute that determines if the device may remove the sector from the NV Cache . The pinned attribute also indicates whether the LBA belongs to the NV Cache Pinned Set or the NV Cache Unpinned Set.

The host manages the NV Cache Pinned Set, Cache Pinned Set (i.e., the set of logical blocks that the host requires the device to keep in the NV Cache) . The remaining NV Cache Set is the NV Cache Unpinned Set.

The NV Cache Pinned Set and the NV Cache Unpinned Set are mutually exclusive . NV Cache Unpinned Set is managed by the device and logical blocks represented in the NV Cache Unpinned Set may be added or removed from the NV Cache Set at any time.

See 7.22.1 for a list of the optional and mandatory commands in this feature set.

4.17.2 Pinning

4.17.2.1 Overview

Adding or Removing an LBA from the NV Cache Pinned Set is accomplished by setting or clearing the pinned attribute on a mapped logical sector . If a device's NV Cache Unpinned Set is too full to satisfy an Add request, then the device shall remove some or all of the NV Cache Unpinned Set in order to complete the Add request.

When an LBA is pinned, the logical sector that is placed into the NV Cache may come from one of two sources:

    a)   the device's media; or
    b)   the host in the form of a write command.

The source of the logical sector is determined by the Populate Immediately (PI) bit in the ADD LBA(S) TO NV CACHE PINNED SET command . See 7.22.3.3.2 for the definition of the PI bit.

4.17.2.2 Examples

A host may pin an LBA:

    a)   for subsequent read operations; and
    b)   that is about to be written.

When the application client requires logical sectors to be accessed frequently (e.g., for preloading frequent randomly accessed operation system files or preloading boot files in preparation for a system reboot), the host may add the logical blocks to the pinned set with the ADD LBA(S) TO NV CACHE PINNED SET command.

An application client that is going to write logical sectors (e.g., writing of the hibernate file in preparation for system hibernation), may add the logical sectors to the pinned set first with the PI bit cleared to zero.

4.17.3 NV Cache Management

4.17.3.1 Overview

The NV Cache management refers to the use of ATA commands to query or take action on the contents of the NV Cache Pinned Set . This is accomplished by transmitting lists of logical sectors that are used in NV Cache management actions . Some NV Cache management actions take lists of logical blocks as inputs and some NV Cache management actions give lists of logical blocks as outputs.

4.17.3.2 LBA Range Entry

An individual LBA range is called an LBA Range Entry and is represented by eight bytes . The LBA is expressed by the LBA Range Entry's first six bytes and the Range Length is a zero based number (e.g., 0=0 and 1=1) represented by the remaining two bytes . If the two byte range length is zero, then the LBA Range Entry shall be discarded as padding .

The following are two examples:

1) If logical blocks 11, 12, 13, 14, 15, 16, 17, and 18 were in the NV Cache Pinned Set and logical blocks 10 and 19 were not, then logical blocks 11 through 18 make one LBA Range Entry that has LBA 11 as its first 48 bits and the value of 8 as its next 16 bits (i.e., 0000_0000_000B_0008h).
2) If only LBA 20 was represented in an LBA Range Entry, then the range value is one (i.e., 0000_0000_0014_0001h).

The largest range that may be specified in a LBA Range Entry is 65 535 . Multiple LBA Range Entries shall be used to specify larger range values.

4.17.3.3 NV Cache Remaining for Pinned logical blocks

If the NV Cache runs out of space for pinned logical sectors, then the number of the remaining available spaces (i.e., Logical Blocks Remaining) shall be returned to the host during the completion of NV Cache Commands.

Logical Blocks Remaining is a six byte number that always represents the number of logical blocks in the total NV Cache size minus the number of logical blocks in the NV Cache Pinned Set.

4.17.4 Rotating media state after power-on event

If the NV Cache power mode is set in a device, then the device should not spin up its rotating media, if any, after after a power-on event until the device receives a command that requires media access.

4.18 NV Cache Power Management feature set

4.18.1 Overview

The NV Cache Power Management feature set permits a host to modify the behavior of a device in a manner that allows the device to improve response times to read and write commands while reducing the device's power consumption .

Commands unique to the NV Cache Power Management feature set use a single command code and are differentiated from one another by the value placed in the Feature field .

See 7.22.2 for a list of the optional and mandatory commands in this feature set.

If the NV Cache power mode is set and the device contains rotating media, then the device carries out an aggressive policy to remove power from its rotational media and process all reads and writes from the device's NV Cache . If a device is not capable of satisfying a read or write from its NV Cache it shall service the read or write request through other means.

The only aspect of the NV Cache feature that affects the Power Management feature set (see 4.19) is the NV Cache power mode input . The purpose of the NV Cache power mode input is to enable and disable the

aggressive spinning down of the device's rotating media while it is in the PM0:Active state . However, the Power Management state diagram does not reflect the state of the rotating media (e.g., spin-up or spin-down) and the NV Cache power mode does not affect any Power Management state transitions . The effects are as follows:

- a) when the device is powered up, it should satisfy requests from NV Cache regardless of its current NV Cache power mode setting so that BIOSes are not required to be NV Cache sensitive;
- b) when the NV Cache power mode is disabled, and the device is in PM0:Active state (see 4.19), the device shall spin up its rotating media;
- c) when the NV Cache power mode is enabled, and the device is in PM0:Active state, the device shall use its aggressive policy to reduce power to any rotating media . The only requirement for this policy is that, when the device is spun up, it remains spun up for at least the amount of time specified in the SET NV CACHE POWER MODE command; and
- d) a Device Configuration Overlay command that disables the NV Cache power mode support in the device causes the NV Cache power mode to be disabled.

4.19 Power Management feature set

4.19.1 Overview

An ATA device shall implement the Power Management feature set . An ATAPI device may implement power management as defined by the command set transported by the PACKET command . Otherwise, an ATAPI device shall implement the Power Management feature set as defined in this standard.

The Power Management feature set allows an application client to modify the behavior of a device in a manner that reduces the power required to operate . The Power Management feature set provides a set of commands and a timer that enable a device to implement low power consumption modes . An ATA device that implements the Power Management feature set shall implement the following (see also 4.5 and 4.20):

- a) the Standby timer;
- b) CHECK POWER MODE command;
- c) IDLE command;
- d) IDLE IMMEDIATE command;
- e) SLEEP command;
- f) STANDBY command; and
- g) STANDBY IMMEDIATE command.

An ATAPI device that implements the Power Management feature set shall implement the following:

- a) CHECK POWER MODE command;
- b) IDLE IMMEDIATE command;
- c) SLEEP command; and
- d) STANDBY IMMEDIATE command.

4.19.2 Power management commands

The CHECK POWER MODE command allows a host to determine if a device is in, going to, or leaving Standby or Idle mode . The CHECK POWER MODE command shall not change the power mode or affect the operation of the Standby timer.

The IDLE command and IDLE IMMEDIATE command move a device to Idle mode immediately from the Active mode or Standby mode . The IDLE command also sets the Standby timer count and enables or disables the Standby timer.

The STANDBY command and STANDBY IMMEDIATE command move a device to Standby mode immediately from the Active mode or Idle mode . The STANDBY command also sets the Standby timer count and enables or disables the Standby timer.

The SLEEP command moves a device to Sleep mode . The device's interface becomes inactive after the device reports command completion for the SLEEP command . A device only transitions from Sleep mode after processing a hardware reset, a software reset, or a DEVICE RESET command .

4.19.3 Standby timer

The Standby timer provides a method for the device to enter Standby mode from either Active mode or Idle mode following a host programmed period of inactivity . If the Standby timer is enabled, and the device is in the Active mode or the Idle mode, then the device waits for the specified time period and, if no command is received, the device enters the Standby mode.

If the Standby timer is disabled, the device may automatically enter Standby mode after a vendor specific time has expired..

See 7.22.11 for interactions with the NV Cache feature set.

4.19.4 Power modes

Figure 14 shows the set of state transitions that shall be implemented.
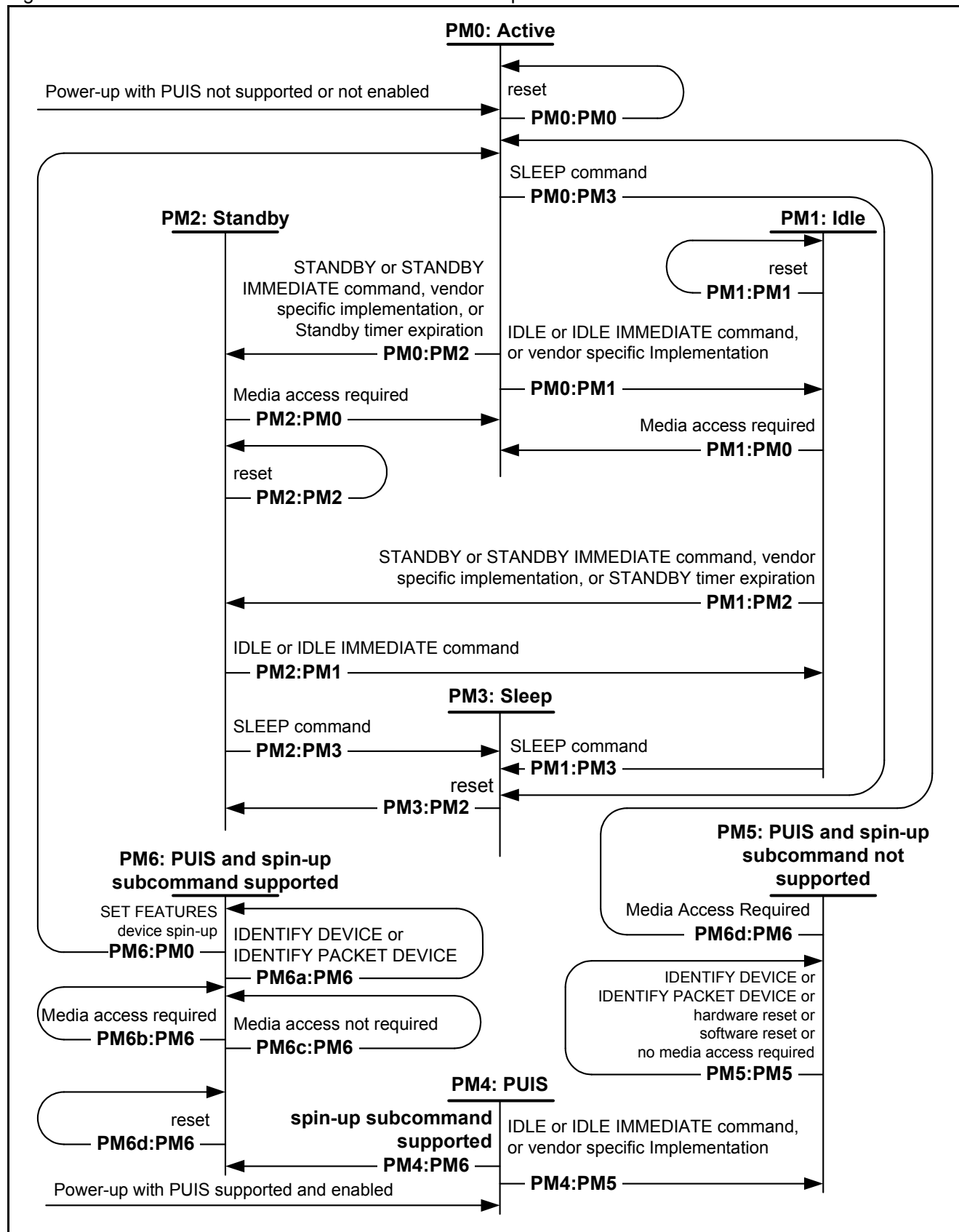
Figure 14 — Power management state diagram

PM0: Active: This state shall be entered when the device receives a media access command while in Idle mode or Standby mode . This state shall also be entered after processing a power cycle if the Power-Up In Standby feature not supported or is not enabled (see 4.20).

In Active mode the device is capable of responding to commands . During the execution of a media access command a device shall be in the Active state . Power consumption is greatest in this state.

Transition PM0:PM0: The device shall transition to the PM0: Active state after processing a hardware reset, software reset, or DEVICE RESET command.

Transition PM0:PM1: If an IDLE command or IDLE IMMEDIATE command is received or a vendor specific implementation determines a transition is required, then the device shall transition to the PM1: Idle state.

Transition PM0:PM2: If a STANDBY command or STANDBY IMMEDIATE command is received, then the Standby timer expires, or a vendor specific implementation determines a transition is required, then the device shall transition to the PM2: Standby state.

Transition PM0:PM3: If a SLEEP command is received, then the device shall transition to the PM3: Sleep state.

PM1: Idle: This state shall be entered when the device receives an IDLE command or IDLE IMMEDIATE command . Some devices may perform vendor specific internal power management and transition to the Idle mode without host intervention.

In Idle mode the device is capable of responding to commands but the device may take longer to complete commands than when in the Active mode . Power consumption may be reduced from that of Active mode.

Transition PM1:PM0: If a media access is required, then the device shall transition to the PM0: Active state.

Transition PM1:PM1: The device shall transition to the PM1: Idle state after processing a hardware reset, software reset, or DEVICE RESET command.

Transition PM1:PM2: The device shall transition to the PM2: Standby state if:

    a) a STANDBY command is processed;
    b) a STANDBY IMMEDIATE command is processed;
    c) the Standby timer expires; or
    d) a vendor specific implementation determines a transition is required.

Transition PM1:PM3: If a SLEEP command is received, then the device shall transition to the PM3: Sleep state.

PM2: Standby: This state shall be entered when:

    e) the device successfully processes a STANDBY command;
    f) the device successfully processes a STANDBY IMMEDIATE command;
    g) the Standby timer expires;
    h) the NV Cache power mode timer expires;
    i) a device performs a vendor specific power management function; or
    j) the device successfully processes a hardware reset, a software reset, or a DEVICE RESET command while in PM2: Standby or PM3: Sleep.

In Standby mode the device is capable of responding to commands but the device may take longer (e.g., 30 seconds) to complete commands than in the Idle mode . Power consumption may be reduced from that of Idle mode.

Transition PM2:PM0: If a media access is required, then the device shall transition to the PM0: Active state.

Transition PM2:PM1: If an IDLE command or IDLE IMMEDIATE command is received, or a vendor specific implementation determines a transition is required, then the device shall transition to the PM1: Idle state.

Transition PM2:PM2: The device shall transition to the PM2: Standby state after processing a hardware reset, software reset, or DEVICE RESET command.

Transition PM2:PM3: If a SLEEP command is received, then the device shall transition to the PM3: Sleep state.

PM3: Sleep: This state shall be entered when the device receives a SLEEP command.

A device transitions from Sleep mode only after processing a hardware reset, a software reset, or a DEVICE RESET command . Processing a hardware reset, a software reset, or a DEIVCE RESET command may take a long time (e.g., 30 seconds) . Sleep state provides the lowest power consumption of any state.

In Sleep state, the device interface behavior is defined in the applicable transport standard.

Transition PM3:PM2:, A device shall transition to the PM2: Standby state after processing a hardware reset, software reset, or DEVICE RESET command.

PM4: PUIS: This state shall be entered when after processing a power cycle if the PUIS feature set (see 4.20) is supported and is enabled.

Transition PM4:PM5: A device shall transition to the PM5: PUIS and spin-up subcommand not supported state if the device does not implement the PUIS feature set device spin-up command (see 7.50.8).

Transition PM4:PM6: A device shall transition to the PM6: PUIS and spin-up subcommand supported state if the device implements the PUIS feature set device spin-up command.

PM5: PUIS and spin-up subcommand not supported: This state shall be entered when after processing a power cycle if the PUIS feature set is supported and is enabled and the device does not implement the PUIS feature set device spin-up subcommand.

In this state, the device is capable of responding to commands but the device may take longer (e.g., 30 seconds) to complete commands than in the Idle mode . Power consumption may be reduced from that of Idle mode.

Transition PM5:PM0: A device shall transition to the PM0: Active state after processing a command, other than IDENTIFY DEVICE command or IDENTIFY PACKET DEVICE command, that requires media access.

Transition PM5:PM5: A device shall transition to the PM5: PUIS and spin-up subcommand not supported state after processing an IDENTIFY DEVICE command or IDENTIFY PACKET DEVICE command, any hardware or software reset, or any command that does not require media access.

PM6: PUIS and spin-up subcommand supported: This state shall be entered when after processing a power cycle if the PUIS feature set is supported and is enabled and the device implements the PUIS feature set device spin-up command.

In this state, the device is capable of responding to commands but the device may take longer (e.g., 30 seconds) to complete commands than in the Idle mode . Power consumption may be reduced from that of Idle mode.

Transition PM6:PM0: A device shall transition to the PM0: Active state after processing a SET FEATURES device spin-up subcommand.

Transition PM6a:PM6: A device shall transition to the PM6: PUIS and spin-up subcommand supported state after processing IDENTIFY DEVICE command or IDENTIFY PACKET DEVICE command.

Transition PM6b:PM6: The device shall transition to the PM6: PUIS and spin-up subcommand supported state after returning command aborted in response to a command, other than IDENTIFY DEVICE command or IDENTIFY PACKET DEVICE, command that requires media access.

Transition PM6c:PM6: A device shall transition to the PM6: PUIS and spin-up subcommand supported state after processing a command, other than IDENTIFY DEVICE command or IDENTIFY PACKET DEVICE command, that does not require media access.

Transition PM6d:PM6: A device shall transition to the PM6: PUIS and spin-up subcommand supported state after processing a hardware reset, software reset, or DEVICE RESET command.

4.20 Power-Up In Standby (PUIS) feature set

The PUIS feature set allows devices to be powered-up into the Standby power management state to minimize inrush current at power-up and to allow the host to sequence the spin-up of devices . This optional feature set may be enabled or disabled via the SET FEATURES command; may be enabled by use of a jumper or similar means, or both . When enabled by a jumper, this feature set shall not be disabled via the SET FEATURES command . The IDENTIFY DEVICE data or IDENTIFY PACKET DEVICE data indicates whether this feature set is implemented and/or enabled.

Once this feature is enabled in a device, the device shall not disable the feature as a result of processing a power cycle, a hardware reset, or a software reset.

A device may implement a SET FEATURES subcommand (see 7.50.8) that notifies the device to spin-up to the Active state when the device has powered-up into Standby . If the device implements this SET FEATURES subcommand and power-up into Standby is enabled, the device shall remain in Standby until the SET FEATURES subcommand is received . If the device implements this SET FEATURES subcommand, the fact that the feature is implemented is reported in the IDENTIFY DEVICE data or IDENTIFY PACKET DEVICE data.

If the device:

   a) implements the Enable/disable Power-up in Standby subcommand;
   b) has the PUIS feature set enabled; and
   c) receives an IDENTIFY DEVICE command or IDENTIFY PACKET DEVICE command while the device is in the Standby power mode as a result of powering up in that mode,

then the device shall respond to the IDENTIFY DEVICE command or IDENTIFY PACKET DEVICE command without spinning up the media . If the device is unable to return a complete response without accessing the media, then the device shall set IDENITFY DEVICE data word 0 bit 2 to one to indicate that the response is incomplete . At a minimum, IDENITFY DEVICE data word 0 and IDENITFY DEVICE data word 2 shall be correctly reported . Those fields that are not provided shall be filled with zeros . Once a device is able to return all data for an IDENTIFY DEVICE command or IDENTIFY PACKET DEVICE command, the device shall return all data for those commands until after processing the next power cycle.

If the device does not implement the SET FEATURES subcommand to spin-up the device after power-up and PUIS is enabled, the device shall spin-up upon receipt of the first command that requires the device to access the media, except the IDENTIFY DEVICE command or the IDENTIFY PACKET DEVICE command.

4.21 Sanitize Device feature set

Sanitize Device operations shall use one of the methods defined in this subclause to make all previously written content in the user data area of the device unable to be read . Sanitize Device operations shall only affect the following:

   a) user data areas;
   b) user data areas that are not currently allocated (e.g., previously allocated areas and physical sectors that have become inaccessible); and
   c) user data caches.

Sanitize Device operations should not return an error if physical sectors that have become inaccessible were not successfully sanitized.

Sanitize Device operations shall not affect non-user data areas (e.g., logs (see Annex A), and Device SMART data structure (see table 155)).

Automatic sector reallocation is permitted during the operation of this function . After completion of a Sanitize Device operation, the device shall:

   a) return an error if physical sectors that are available to be allocated for user data (e.g . allocated physical sectors or unallocated physical sectors allowed by vendor-specific means to be usable for user data) were not successfully sanitized; or
   b) set the Sanitize Operation Complete Without Error bit if:
      A) all physical sectors that are available to be allocated for user data have been successfully sanitized; and
      B) any physical areas that were not successfully sanitized were removed from use.

To perform a Sanitize Device operation the host should issue:

   a) CRYPTO SCRAMBLE EXT command (see 7.43.3);
   b) BLOCK ERASE EXT command (see 7.43.2); or
   c) OVERWRITE EXT command (see 7.43.4),

followed by a SANITIZE STATUS EXT command (see 7.43.6) to check for completion.

After a device has started processing a Sanitize Device operation, and until the device transitions to the Sanitize Idle state, the device shall abort all commands other than IDENTIFY DEVICE command, REQUEST SENSE DATA EXT command and SANITIZE STATUS EXT command . If a Sanitize Device operation is interrupted by a power cycle, the Sanitize Device operation shall continue to completion before reporting ready

The SANITIZE STATUS EXT command returns information about the current Sanitize Device operation, if any, and a percentage of completion if a Sanitize Device operation is in progress.

An accepted CRYPTO SCRAMBLE EXT command, BLOCK ERASE EXT command, or OVERWRITE EXT command shall transition the device into the Sanitize Operation state . The device shall remain in this state until the device has completed the Sanitize Device operation (see figure 15).

The SANITIZE FREEZE LOCK EXT command (see 7.43.5) shall cause the device to transition to the Sanitize Frozen state and shall cause any subsequent CRYPTO SCRAMBLE EXT command, BLOCK ERASE EXT command, and OVERWRITE EXT command to be aborted . If the device processes a power cycle or a hardware reset, then the device shall transition from the Sanitize Frozen state to the Sanitize Idle state.

A device implementing this feature set shall implement one or more of the following sanitization methods:

    a)   cryptographic scramble;
    b)   block erase; or
    c)   overwrite.

The cryptographic scramble method and block erase method make previously written contents in the user data area unretrievable.

The overwrite method fills all user data with a four byte pattern passed within the LBA field of the command . Parameters for this method include a count for multiple overwrites and the option to invert the four byte pattern between consecutive overwrite passes.

A software reset shall not cause the Sanitize operation state to change.

Figure 15 describes the operation of the Sanitize Device feature set.
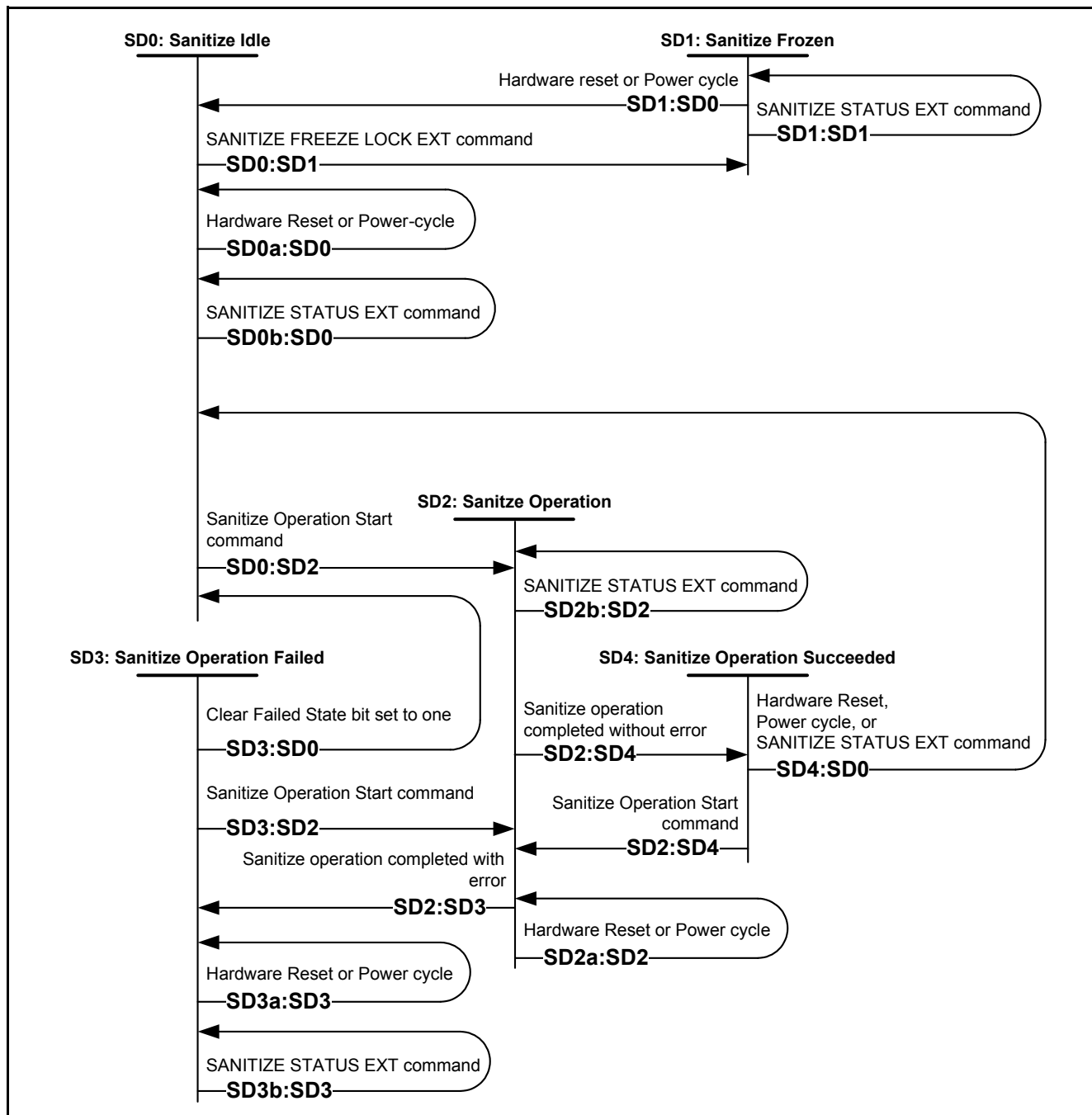
Figure 15 — Sanitize Device state machine

SD0: Sanitize Idle State: This state is entered when the device processes a power cycle from SD0, SD1, or SD4.

Transition SD0a:SD0: If the device is:

  a) in the Sanitize Idle state; and
  b) processes a hardware reset or power cycle,

then the device shall remain in the SD0 Sanitize Idle state.

Transition SD0b:SD0: When the device is in the Sanitize Idle state and it processes a SANITIZE STATUS EXT command, the device shall complete the command and remain in the SD0 Sanitize Idle state.

Transition SD0:SD1: When the device is in the Sanitize Idle state and it processes a SANITIZE FREEZE LOCK EXT command, the device shall transition to the SD1 Sanitize Frozen state.

Transition SD0:SD2: When the device is in the Sanitize Idle state and it processes a supported Sanitize Operation Start command, the device shall transition to the SD2 Sanitize Operation state.

SD1: Sanitize Frozen State: This state is entered from the SD0 Sanitize Idle state when the device processes a SANITIZE FREEZE LOCK EXT command.

Transition SD1:SD0: When the device is in the Sanitize Frozen state and it processes a hardware reset or a power cycle, the device shall transition to the SD0 Sanitize Idle state.

Transition SD1:SD1: When the device is in the Sanitize Frozen state and it processes a SANITIZE STATUS EXT command, the device shall complete the command and remain in the SD1 Sanitize Frozen state.

SD2: Sanitize Operation State: This state is entered when:

   a) the device processes a power cycle from SD2; or
   b) the device is in the SD0 Sanitize Idle state and a supported Sanitize Operation Start command is received.

Transition SD2a:SD2: If the device is:

   a) in the Sanitize Operation state; and
   b) processes a hardware reset or power cycle,

then the device shall remain in the SD2 Sanitize Operation state.

Transition SD2b:SD2: When the device is in the Sanitize Operation state and it processes a SANITIZE STATUS EXT command, the device shall remain in the SD2 Sanitize Operation state.

Transition SD2:SD3: When the device is in the Sanitize Operation state and a Sanitize Operation completes with an error, the device shall transition to the SD3 Sanitize Operation Failed state.

Transition SD2:SD4: When the device is in the Sanitize Operation state and a Sanitize Operation completes without an error, the device shall transition to the SD4 Sanitize Operation Succeeded state.

SD3: Sanitize Operation Failed State: This state is entered when:

   a) the device processes a power cycle from SD3; or
   b) the device is in the SD2 Sanitize Operation state and a Sanitize Operation completes with an error.

Transition SD3:SD0: When the device is in the Sanitize Operation Failed state and:

   a) the Sanitize Operation was initiated by a Sanitize Device command with the Failure Mode bit set to one; and
   b) the SANITIZE STATUS EXT command has been successfully processed with the Clear Sanitize Operation Failed bit set to one,

then the device shall transition to the Sanitize Idle state.

Transition SD3:SD2: When the device is in the Sanitize Operation Failed state and it processes a supported Sanitize Operation Start command, the device shall transition to the SD2 Sanitize Operation state.

Transition SD3a:SD3: When the device is in the Sanitize Operation Failed state and it processes a processes a hardware reset or power cycle, the device shall remain in the SD3 Sanitize Operation Failed state.

Transition SD3b:SD3: When the device is in the Sanitize Operation Failed state, and it processes a SANITIZE STATUS EXT command with the Clear Sanitize Operation Failed bit cleared to zero, the device shall remain in the SD3 Sanitize Operation Failed state.

SD4: Sanitize Operation Succeeded State: This state is entered when the device is in the SD2 Sanitize Operation state and a Sanitize Operation completes without an error.

Transition SD4:SD0: If the device is in the Sanitize Operation state and it processes:

   a) a hardware reset;
   b) a power cycle; or

    c)   a SANITIZE STATUS EXT command,

then the device shall transition to the SD0 Sanitize Idle state.

Transition SD4:SD2: When the device is in the Sanitize Operation state and it processes a supported Sanitize Operation Start command, the device shall transition to the SD2 Sanitize Operation state.

4.22 Security feature set

4.22.1 Overview

The optional Security feature set is a password system that restricts access to user data stored on a device . Access to some configuration capabilities are limited.

The Master Password Identifier feature (see 4.22.11) is an optional enhancement to the Security feature set.

4.22.2 Passwords

4.22.2.1 Overview

The system has two types of passwords:

    a)   User; and
    b)   Master.

4.22.2.2 User Password

The User password creates a lock to block processing of some commands, including preventing access to all user data on the device . The User password may be used to unlock the device to allow access.

Security is enabled by setting a User password with the SECURITY SET PASSWORD command . When security is enabled, the device is Locked (i.e., access to user data on the device is denied) after a power cycle is processed until a SECURITY UNLOCK command completes without error.

4.22.2.3 Master Password

The Master password is a password that may be used to unlock the device if the User password is lost or if an administrator requires access (e.g., to repurpose a device).

A factory-installed Master password may be valid before an initial SECURITY SET PASSWORD command has been completed without error . A device may contain both a valid Master password and a valid User password . Setting the Master password does not enable security (i.e., does not Lock the device after the next power cycle has been processed).

4.22.3 Master Password Capability

A device with security enabled has two ways of using the Master password . This capability has values of High or Maximum . The capability value is set when the User password is set (see 7.48).

When the Master Password Capability is set to High, either the User password or Master password may be used interchangeably.

When the Master Password Capability is set to Maximum, the Master password is not used with the SECURITY DISABLE PASSWORD command and SECURITY UNLOCK command . The SECURITY ERASE UNIT command, however, does accept either a valid User or Master password.

4.22.4 Frozen Mode

The SECURITY FREEZE LOCK command prevents changes to all Security states until a following power cycle or hardware reset . The purpose of the SECURITY FREEZE LOCK command is to prevent password setting attacks on the security system.

4.22.5 Commands

A device that implements the Security feature set shall implement the following set of commands:

    a)   SECURITY SET PASSWORD;
    b)   SECURITY UNLOCK;
    c)   SECURITY ERASE PREPARE;

    d)   SECURITY ERASE UNIT;
    e)   SECURITY FREEZE LOCK; and
    f)   SECURITY DISABLE PASSWORD.

4.22.6 IDENTIFY DEVICE data

Support of the Security feature set is indicated in IDENTIFY DEVICE data words 82 and 128 (see 7.18.7.40 and 7.18.7.66) and IDENTIFY PACKET DEVICE data words 82 and 128 (see 7.19.6.34 and 7.19.6.51).

Security information in IDENTIFY DEVICE data words 82, 89 and 90 (see table 54) and IDENTIFY PACKET DEVICE data words 82, 89 and 90 (see table 65) is fixed until the next power cycle and shall not change unless the DEVICE CONFIGURATION OVERLAY command removes support for the Security feature set.

Security information in IDENTIFY DEVICE data words 85, 92 and 128 and IDENTIFY DEVICE data words 85, 92 and 128 are variable and may change.

If the Security feature set is not supported, then IDENTIFY DEVICE data words 89, 90, 92 and 128 and IDENTIFY PACKET DEVICE data words 89, 90, 92 and 128 are N/A.

4.22.7 Security initial setting

When the device is shipped by the manufacturer, security shall be disabled (e.g., is not Locked) . The initial Master password value is not defined by this standard.

4.22.8 Password Rules

This subclause applies to any security command that accepts a password, and for which there exists a valid password . This subclause does not apply after the drive has processed a SECURITY FREEZE LOCK command without error.

The SECURITY ERASE UNIT command ignores the Master Password Capability value when comparing passwords, and shall accept either a valid Master password or User password.

If the User password sent to the device does not match the User password previously set with the SECURITY SET PASSWORD command, then the device shall return command aborted .

If the Master Password Capability was set to High during the last SECURITY SET PASSWORD command setting the User password, then the device shall accept the Master password and complete the command without error.

If the Master Password Capability was set to Maximum during the last SECURITY SET PASSWORD command setting the User password, then the device shall return command aborted for a SECURITY UNLOCK command or a SECURITY DISABLE PASSWORD command if the Master password is supplied.

4.22.9 Password attempt counter

The device shall have a password attempt counter . The counter shall be decremented while in SEC4 state (see figure 16), whenever the SECURITY UNLOCK command fails because of an invalid User password or Master password .

When the password attempt counter reaches zero, the device shall:

    a)   not decrement the counter;
    b)   set the Password Attempt Counter Exceeded bit (i.e., bit 4 of word 128 in the IDENTIFY DEVICE data) to one; and
    c)   return command aborted for all SECURITY UNLOCK commands and SECURITY ERASE UNIT commands until after the device processes a power-on or hardware reset.

The Password Attempt Counter Exceeded bit shall be cleared to zero after processing a power-on or a hardware reset.

The password attempt counter shall be set to five after a power-on or hardware reset .

4.22.10 Security states

Figure 16 describes security states and state transitions, table 9 is a summary of the security states, and table 10 describes the effect of security on commands . When the power is off, the security characteristics are as in table 9, but are not reportable.

Table 9 — Summary of Security States and Security Characteristics

Security State	Security Characteristics				
	Power	Enabled[a]	Locked[b]	Frozen[c]	Password Attempts Exceeded[d]
SEC0	off	0	N/A	N/A	N/A
SEC1	on	0	0	0	0
SEC2	on	0	0	1	Varies
SEC3	off	1	N/A	N/A	N/A
SEC4	on	1	1	0	Varies
SEC5	on	1	0	0	Varies
SEC6	on	1	0	1	Varies

[a] IDENTIFY DEVICE data word 85 bit 1 (see 7.18.7.41)
[b] IDENTIFY DEVICE data word 128 bit 2 (see 7.18.7.66)
[c] IDENTIFY DEVICE data word 128 bit 3 (see 7.18.7.66)
[d] IDENTIFY DEVICE data word 128 bit 4 (see 7.18.7.66)

Table 10 — Security Command Actions (part 1 of 4)

Command	Locked [a]	Unlocked or Disabled [b]	Frozen [c]
ADD LBA(S) TO NV CACHE PINNED SET	Command aborted	Executable	Executable
BLOCK ERASE EXT	Command aborted	Executable	Executable
CFA ERASE SECTORS	Command aborted	Executable	Executable
CFA REQUEST EXTENDED ERROR CODE	Executable	Executable	Executable
CFA TRANSLATE SECTOR	Executable	Executable	Executable
CFA WRITE MULTIPLE WITHOUT ERASE	Command aborted	Executable	Executable
CFA WRITE SECTORS WITHOUT ERASE	Command aborted	Executable	Executable
CHECK MEDIA CARD TYPE	Command aborted	Executable	Executable
CHECK POWER MODE	Executable	Executable	Executable
CONFIGURE STREAM	Command aborted	Executable	Executable
CRYPTO SCRAMBLE EXT	Command aborted	Executable	Executable
DATA SET MANAGEMENT	Command aborted	Executable	Executable
DEVICE CONFIGURATION	Command aborted	Executable	Executable
DEVICE RESET	Executable	Executable	Executable
DOWNLOAD MICROCODE	Vendor Specific	Vendor Specific	Vendor Specific
DOWNLOAD MICROCODE DMA	Vendor Specific	Vendor Specific	Vendor Specific
EXECUTE DEVICE DIAGNOSTIC	Executable	Executable	Executable
FLUSH CACHE	Command aborted	Executable	Executable
FLUSH CACHE EXT	Command aborted	Executable	Executable
FLUSH NV CACHE	Command aborted	Executable	Executable
GET MEDIA STATUS	Command aborted	Executable	Executable
IDENTIFY DEVICE	Executable	Executable	Executable
IDENTIFY PACKET DEVICE	Executable	Executable	Executable
IDLE	Executable	Executable	Executable
IDLE IMMEDIATE	Executable	Executable	Executable
MEDIA EJECT	Command aborted	Executable	Executable
MEDIA LOCK	Command aborted	Executable	Executable
MEDIA UNLOCK	Command aborted	Executable	Executable
NOP	Executable	Executable	Executable
OVERWRITE EXT	Command aborted	Executable	Executable
PACKET	Command aborted	Executable	Executable
QUERY NV CACHE MISSES	Command aborted	Executable	Executable
Note - all commands not listed in this table are not addressed by the Security feature set.			

[a] State SEC4
[b] States SEC1 or SEC5
[c] States SEC2 or SEC6

Table 10 — Security Command Actions (part 2 of 4)

Command	Locked [a]	Unlocked or Disabled [b]	Frozen [c]
QUERY NV CACHE PINNED SET	Command aborted	Executable	Executable
READ BUFFER	Executable	Executable	Executable
READ BUFFER DMA	Executable	Executable	Executable
READ DMA	Command aborted	Executable	Executable
READ DMA EXT	Command aborted	Executable	Executable
READ FPDMA QUEUED	Command aborted	Executable	Executable
READ LOG DMA EXT	Executable	Executable	Executable
READ LOG EXT	Executable	Executable	Executable
READ MULTIPLE	Command aborted	Executable	Executable
READ MULTIPLE EXT	Command aborted	Executable	Executable
READ NATIVE MAX ADDRESS	Executable	Executable	Executable
READ NATIVE MAX ADDRESS EXT	Executable	Executable	Executable
READ SECTOR(S)	Command aborted	Executable	Executable
READ SECTOR(S) EXT	Command aborted	Executable	Executable
READ STREAM DMA EXT	Command aborted	Executable	Executable
READ STREAM EXT	Command aborted	Executable	Executable
READ VERIFY SECTOR(S)	Command aborted	Executable	Executable
READ VERIFY SECTOR(S) EXT	Command aborted	Executable	Executable
REMOVE LBA(S) FROM NV CACHE PINNED SET	Command aborted	Executable	Executable
REQUEST SENSE DATA EXT	Executable	Executable	Executable
RETURN FROM NV CACHE POWER MODE	Command aborted	Executable	Executable
SANITIZE FREEZE LOCK EXT	Command aborted	Executable	Executable
SANITIZE STATUS EXT	Command aborted	Executable	Executable
SCT WRITE SAME	Command aborted	Executable	Executable
SCT ERROR RECOVERY CONTROL	Command aborted	Executable	Executable
SCT FEATURE CONTROL	Command aborted	Executable	Executable
SCT DATA TABLES	Command aborted	Executable	Executable
SCT READ STATUS	Executable	Executable	Executable
SECURITY DISABLE PASSWORD	Command aborted	Executable	Command aborted
SECURITY ERASE PREPARE	Executable	Executable	Command aborted
SECURITY ERASE UNIT	Executable	Executable	Command aborted
SECURITY FREEZE LOCK	Command aborted	Executable	Executable
SECURITY SET PASSWORD	Command aborted	Executable	Command aborted
SECURITY UNLOCK	Executable	Executable	Command aborted
Note - all commands not listed in this table are not addressed by the Security feature set.			
[a] State SEC4 [b] States SEC1 or SEC5 [c] States SEC2 or SEC6			

Table 10 — Security Command Actions (part 3 of 4)

Command	Locked [a]	Unlocked or Disabled [b]	Frozen [c]
SERVICE	Command aborted	Executable	Executable
SET FEATURES	Executable	Executable	Executable
SET MAX ADDRESS	Command aborted	Executable	Executable
SET MAX ADDRESS EXT	Command aborted	Executable	Executable
SET MAX SET PASSWORD	Command aborted	Executable	Executable
SET MAX SET PASSWORD DMA	Command aborted	Executable	Executable
SET MAX LOCK	Command aborted	Executable	Executable
SET MAX FREEZE LOCK	Command aborted	Executable	Executable
SET MAX UNLOCK	Command aborted	Executable	Executable
SET MAX UNLOCK DMA	Command aborted	Executable	Executable
SET MULTIPLE MODE	Executable	Executable	Executable
SET NV CACHE POWER MODE	Command aborted	Executable	Executable
SLEEP	Executable	Executable	Executable
SMART DISABLE OPERATIONS	Executable	Executable	Executable
SMART ENABLE/DISABLE AUTOSAVE	Executable	Executable	Executable
SMART ENABLE OPERATIONS	Executable	Executable	Executable
SMART EXECUTE OFF-LINE IMMEDIATE	Executable	Executable	Executable
SMART READ DATA	Executable	Executable	Executable
SMART READ LOG	Executable	Executable	Executable
SMART RETURN STATUS	Executable	Executable	Executable
SMART WRITE LOG	Executable	Executable	Executable
STANDBY	Executable	Executable	Executable
STANDBY IMMEDIATE	Executable	Executable	Executable
Note - all commands not listed in this table are not addressed by the Security feature set. [a] State SEC4 [b] States SEC1 or SEC5 [c] States SEC2 or SEC6			

Table 10 — **Security Command Actions** (part 4 of 4)

Command	Locked [a]	Unlocked or Disabled [b]	Frozen [c]
TRUSTED RECEIVE	Command aborted	Executable	Executable
TRUSTED RECEIVE DMA	Command aborted	Executable	Executable
TRUSTED SEND	Command aborted	Executable	Executable
TRUSTED SEND DMA	Command aborted	Executable	Executable
WRITE BUFFER	Executable	Executable	Executable
WRITE BUFFER DMA	Executable	Executable	Executable
WRITE DMA	Command aborted	Executable	Executable
WRITE DMA EXT	Command aborted	Executable	Executable
WRITE DMA FUA EXT	Command aborted	Executable	Executable
WRITE FPDMA QUEUED	Command aborted	Executable	Executable
WRITE LOG DMA EXT	Command aborted	Executable	Executable
WRITE LOG EXT	Command aborted	Executable	Executable
WRITE MULTIPLE	Command aborted	Executable	Executable
WRITE MULTIPLE EXT	Command aborted	Executable	Executable
WRITE MULTIPLE FUA EXT	Command aborted	Executable	Executable
WRITE SECTOR(S)	Command aborted	Executable	Executable
WRITE SECTOR(S) EXT	Command aborted	Executable	Executable
WRITE STREAM DMA EXT	Command aborted	Executable	Executable
WRITE STREAM EXT	Command aborted	Executable	Executable
WRITE UNCORRECTABLE EXT	Command aborted	Executable	Executable

Note - all commands not listed in this table are not addressed by the Security feature set.

[a] State SEC4
[b] States SEC1 or SEC5
[c] States SEC2 or SEC6

SEC0: Powered down/
Disabled/Not Locked/
Not Frozen

SEC2: Disabled/
Not Locked/Frozen

Power-down
SEC2:SEC0

SEC1: Disabled/ Not
Locked/ Not Frozen

Power-up
SEC0:SEC1

Hardware Reset
SEC2:SEC1

Power-down
SEC1:SEC0

SECURITY FREEZE LOCK command
SEC1:SEC2

Hardware Reset
SEC1:SEC1

Note: **Some events may change**
Security characteristics without
changing state in this figure

SEC5: Enabled/
Not Locked/
Not Frozen

SECURITY SET PASSWORD
command (user)
SEC1:SEC5

SECURITY SET PASSWORD command (master)
SEC1a:SEC1

SECURITY DISABLE PASSWORD
command
or
SECURITY ERASE UNIT command
SEC5:SEC1

SEC3: Powered down/
Enabled/Locked/
Not Frozen

SEC4: Enabled/
Locked/Not Frozen

SECURITY UNLOCK command
(correct password, Password
Attempt Counter > 0)
SEC4:SEC5

SECURITY ERASE
UNIT command
SEC4:SEC1

Power-up
SEC3:SEC4

Hardware Reset
SEC5:SEC4

Power-down
SEC4:SEC3

Hardware Reset
SEC4:SEC4

SECURITY UNLOCK command
SECURITY ERASE PREPARE
command
SEC4a:SEC4

SECURITY SET PASSWORD
command
SEC5:SEC5

SEC6: Enabled/
Not Locked/Frozen

Hardware Reset
SEC6:SEC4

SECURITY FREEZE
LOCK command
SEC5:SEC6

Power-down
SEC6:SEC3

Power-down
SEC5:SEC3

Figure 16 — Security state diagram

State SEC0: Powered down/Security Disabled/Not Locked/ Not Frozen: This state shall be entered when the device is powered-down with the Security feature set disabled.

Transition SEC0:SEC1: When the device is powered-up, the device shall transition to the SEC1 state.

State SEC1: Security Disabled/Not Locked/Not Frozen: This state shall be entered when the device is powered-up or a hardware reset is received with the Security feature set disabled or when the Security feature set is disabled by a SECURITY DISABLE PASSWORD command or SECURITY ERASE UNIT command.

When entering this state after processing a power-on or hardware reset, the device shall set the password attempt counter to a value of five and clear the Password Attempt Counter Exceeded flag.

In this state, the device shall respond to all commands as specified in the Disabled column of table 10 . With the exception of the SECURITY commands, processing of these commands shall not cause a transition from state SEC1.

The device shall report IDENTIFY DEVICE command and IDENTIFY PACKET DEVICE command data words as described in table 11.

Table 11 — IDENTIFY settings for Security state SEC1

Word	Bit Position	Value	Description
82	1	1	Security feature set is supported
85	1	0	There is no active User password
128	0	copy of word 82 bit 1	Security feature set is supported
128	1	copy of word 85 bit 1	Security feature set is disabled
128	2	0	device is not locked
128	3	0	device is not frozen
128	4	Varies	Password Attempt Counter Exceeded 1= counter exceeded 0= counter not exceeded
128	8	0	Master Password Capability is not maximum

Transition SEC1:SEC0: When the device is powered-down, the device shall transition to the SEC0 state.

Transition SEC1:SEC1: When the device receives a hardware reset, the device shall remain in the same state.

Transition SEC1a:SEC1: When a SECURITY SET (master) PASSWORD command completes without error, the device shall:

   a) save the Master password and the optional Master Password Identifier;
   b) remain in the same state; and
   c) not change the Master Password Capability.

Transition SEC1:SEC2: When a SECURITY FREEZE LOCK command completes without error, the device shall transition to the SEC2 state.

Transition SEC1:SEC5: When a SECURITY SET (user) PASSWORD command completes without error, the device shall:

   a) save the User password;
   b) update the Master Password Capability; and
   c) transition to the SEC5 state.

State SEC2: Security Disabled/Not Locked/Frozen: This state shall be entered when the device receives a SECURITY FREEZE LOCK command while in state SEC1.

In this state, the device shall respond to all commands as specified in the Frozen column of table 10 . Processing of any of these commands shall not cause a transition from state SEC2.

The device shall report IDENTIFY DEVICE data words and IDENTIFY PACKET DEVICE data words as described in table 12.

Table 12 — IDENTIFY settings for Security state SEC2

Word	Bit Position	Value	Description
82	1	1	Security feature set is supported
85	1	0	There is no active User password
128	0	copy of word 82 bit 1	Security feature set is supported
128	1	copy of word 85 bit 1	Security feature set is disabled
128	2	0	device is not locked
128	3	1	device is frozen
128	4	Varies	Password Attempt Counter Exceeded 1= counter exceeded 0= counter not exceeded
128	8	Varies	Master Password Capability 0=high/User password disabled 1=Maximum/User password disabled

Transition SEC2:SEC0: When the device is powered-down, the device shall transition to the SEC0 state.

Transition SEC2:SEC1: When the device receives a hardware reset, the device shall transition to the SEC1 state.

State SEC3: Powered down/Security Enabled/ Locked/ Not Frozen: This state shall be entered when the device is powered-down with the Security feature set enabled.

Transition SEC3:SEC4: When the device is powered-up, the device shall transition to the SEC4 state.

State SEC4: Security Enabled/ Locked/ Not Frozen: This state shall be entered when the device is powered-up or a hardware reset is received with the Security feature set enabled.

In this state, the device shall respond to all commands as specified in the Locked column of table 10 . With the exception of the SECURITY commands, execution of these commands shall not cause a transition from state SEC4.

When entering this state from power-on or hardware reset, the device shall set the password attempt counter to a value of 5 and clear the Password Attempt Counter Exceeded flag

The device shall report IDENTIFY DEVICE data words and the IDENTIFY PACKET DEVICE data words as described in table 13.

Table 13 — IDENTIFY settings for Security state SEC4

Word	Bit Position	Value	Description
82	1	1	Security feature set is supported
85	1	1	There is an active User password
128	0	copy of word 82 bit 1	Security feature set is supported
128	1	copy of word 85 bit 1	Security feature set is enabled
128	2	1	device is locked
128	3	0	device is not frozen
128	4	Varies	Password Attempt Counter Exceeded 1= counter exceeded 0= counter not exceeded
128	8	Varies	Master Password Capability 0=high 1=Maximum

Transition SEC4:SEC1: When a SECURITY ERASE UNIT command completes without error, then the device shall transition to the SEC1 state.

Transition SEC4:SEC3: When the device is powered-down, the device shall transition to the SEC3 state.

Transition SEC4:SEC4: When the device receives a hardware reset, the device shall remain in the same state.

Transition SEC4a:SEC4: When a SECURITY UNLOCK command is received with an incorrect password, the password attempt counter shall be decremented by one, and remain in the same state.

If the password attempt counter reaches zero, then the Password Attempt Counter Exceeded bit shall be set to one.

After execution of the SECURITY ERASE PREPARE command, the device remains in the same state.

Transition SEC4:SEC5: When a SECURITY UNLOCK command is successful, the device shall transition to the SEC5 state.

State SEC5: Security Enabled/ Not Locked/ Not Frozen: This state shall be entered when either a SECURITY SET (user) PASSWORD command or a SECURITY UNLOCK command completes without error.

In this state, the device shall respond to all commands as specified in the Unlocked column of table 10 . With the exception of the SECURITY commands, execution of these commands shall not cause a transition from state SEC5.

The device shall report IDENTIFY DEVICE command or IDENTIFY PACKET DEVICE command data words as described in table 14.

Table 14 — IDENTIFY settings for Security state SEC5

Word	Bit Position	Value	Description
82	1	1	Security feature set is supported
85	1	1	There is an active User password
128	0	copy of word 82 bit 1	Security feature set is supported
128	1	copy of word 85 bit 1	Security feature set is enabled
128	2	0	device is not locked
128	3	0	device is not frozen
128	4	Varies	Password Attempt Counter Exceeded 1= counter exceeded 0= counter not exceeded
128	8	Varies	Master Password Capability 0=high 1=Maximum

Transition SEC5:SEC1: If a SECURITY DISABLE PASSWORD command or a SECURITY ERASE UNIT command is successful, then the device shall transition to the SEC1 state.

Transition SEC5:SEC3: When the device is powered-down, the device shall transition to the SEC3 state.

Transition SEC5:SEC4: When the device receives a hardware reset, the device shall transition to the SEC4 state.

Transition SEC5:SEC5: When a SECURITY SET (master) PASSWORD command completes without error, the device shall:

    a)   save the Master password and the optional Master Password Identifier;
    b)   not change the Master Password Capability; and
    c)   remain in the same state.

When a SECURITY SET (user) PASSWORD command completes without error, the device shall:

    a)   save the User password;
    b)   update the Master Password Capability; and
    c)   remain in the same state.

When a SECURITY ERASE PREPARE command completes without error, the device shall remain in the same state.

Transition SEC5:SEC6: When a SECURITY FREEZE LOCK command is successful, the device shall transition to the SEC6 state.

State SEC6: Security Enabled/ Not Locked/ Frozen: This state shall be entered when the device receives a SECURITY FREEZE LOCK command while in the SEC5 state.

In this state, the device shall respond to all commands as specified in the Frozen column of table 10 . With the exception of the SECURITY commands, execution of these commands shall not cause a transition from state SEC6.

The device shall report IDENTIFY DEVICE command or IDENTIFY PACKET DEVICE command data words as described in table 15.

Table 15 — IDENTIFY settings for Security state SEC6

Word	Bit Position	Value	Description
82	1	1	Security feature set is supported
85	1	1	There is an active User password
128	0	copy of word 82 bit 1	Security feature set is supported
128	1	copy of word 85 bit 1	Security feature set is enabled
128	2	0	device is not locked
128	3	1	device is frozen
128	4	Varies	Password Attempt Counter Exceeded 1= counter exceeded 0= counter not exceeded
128	8	Varies	Master Password Capability 0=high 1=Maximum

Transition SEC6:SEC4: When the device receives a hardware reset, the device shall transition to the SEC4 state.

Transition SEC6:SEC3: When the device is powered-down, the device shall transition to the SEC3 state.

4.22.11 Master Password Identifier feature

4.22.11.1 Overview

The Master Password Identifier is an optional feature in the Security feature set.

4.22.11.2 Example use case

This feature allows an administrator to use several sets of Master passwords (e.g., for use in different deployments of devices) . The administrator may maintain a mapping of actual Master passwords and a corresponding Identifier . When an administrator sets a Master password, the corresponding Master Password Identifier may also be set.

If a User password had been set and lost, an administrator may obtain a hint as to which Master password was previously set from the Master Password Identifier.

4.22.11.3 Requirements

The device shall maintain a value associated with the Master Password that may be specified by the host.

The Master Password Identifier does not indicate whether a Master Password exists or is valid.

Support for this feature is reported in the IDENTIFY DEVICE data or IDENTIFY PACKET DEVICE data in word 92 . Valid identifiers are 0001h through FFFEh . A value of 0000h or FFFFh indicates that this feature is not supported .

If the device supports the Security feature set, then:

  a) the device shall store a non-volatile identifier field with the stored Master password;
  b) the identifier is maintained for the benefit of the host and shall not be modified by the device; and
  c) prior to first use, the Master Password Identifier shall be set to FFFEh by the manufacturer.

4.23 Self-Monitoring, Analysis, and Reporting Technology (SMART) feature set

4.23.1 Overview

The Self-Monitoring, Analysis, and Reporting Technology (SMART) feature set allows for the protection of user data and minimizes the likelihood of unscheduled system downtime that may be caused by predictable degradation and/or fault of the device . SMART feature set devices attempt to predict the likelihood of near-term degradation or fault condition . The SMART feature set provides the host with the knowledge of a negative reliability condition . Support of this feature set is indicated in the IDENTIFY DEVICE data.

4.23.2 Device SMART data structure

SMART feature set capability and status information for the device are stored in the device SMART data structure . The off-line data collection capability and status data stored in the SMART data structure may be useful to the host if the SMART EXECUTE OFF-LINE IMMEDIATE command is implemented (see 7.55.5).

4.23.3 Background data collection

Collection of SMART data in the background shall have no impact on device performance . The SMART data that is collected or the methods by which data is collected in the background may be different than those in the off-line data collection mode for any particular device and may vary from one device to another.

4.23.4 Off-line/Captive mode data collection

If the device is required to respond to commands from the host while performing data collection, then the device shall use the off-line mode or captive mode for data collection and self-test routines that have an impact on performance . This impact on performance may vary from device to device . The data that is collected or the methods by which the data is collected in this mode may be different than those in the background data collection mode for any particular device and may vary from one device to another.

4.23.5 Threshold exceeded condition

This condition occurs when the device's SMART reliability status indicates an impending degrading or fault condition (see 7.55.8).

4.23.6 SMART feature set commands

These commands use a single command code and are differentiated from one another by the value placed in the Feature field (see 7.55).

If the SMART feature set is implemented, the following commands shall be implemented:

a) SMART DISABLE OPERATIONS;
b) SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE;
c) SMART ENABLE OPERATIONS; and
d) SMART RETURN STATUS.

If the SMART feature set is implemented, the following commands are optional:

a) SMART EXECUTE OFF-LINE IMMEDIATE;
b) SMART READ DATA;
c) SMART READ LOG; and
d) SMART WRITE LOG.

4.23.7 SMART operation with power management modes

When the SMART feature set is enabled a device should save the device accumulated SMART data upon receipt of an IDLE IMMEDIATE command, STANDBY IMMEDIATE command, or SLEEP command or upon return to an Active state or Idle state from a Standby state (see 7.55.6).

If a SMART feature set enabled device has been set to use the Standby timer (see 4.19.3), the device should save the device accumulated SMART data prior to going from an Idle state to the Standby state or upon return to an Active state or Idle state from a Standby state.

A device shall not process any routine to save the device accumulated SMART data while the device is in a Standby state or Sleep state.

4.23.8 SMART device error log reporting

Logging of reported errors is an optional SMART feature . If error logging is supported by a device, it is indicated in byte 370 of the SMART READ DATA command response (see table 155) and IDENTIFY DEVICE DATA word 84 bit 0 (see 7.18.7.40) . If error logging is supported, the device shall provide information on the last five errors that the device reported as described in the SMART READ LOG command (see 7.55.7) . The device may also provide additional vendor specific information on these reported errors.

If error logging is supported, it shall not be disabled when SMART is disabled . Error log information shall be gathered when the device is powered-on except that logging of errors when in a reduced power mode is optional . If errors are logged when in a reduced power mode, the reduced power mode shall not change . Disabling SMART shall disable the delivering of error log information via the SMART READ LOG command.

The SMART error logs are: the Summary Error Log, the Comprehensive Error Log and the Extended Comprehensive Error Log.

4.24 Sense Data Reporting feature set

The Sense Data Reporting feature set allows devices to report that additional error or non-error informational status is available from the device and may be retrieved by the host . This feature set is prohibited for devices implementing the PACKET command feature set.

The REQUEST SENSE DATA EXT command (see 7.42) and the SET FEATURES subcommand Enable/Disable the Sense Data Reporting feature set (see 7.50.17) are mandatory for this feature set.

This feature is enabled by issuing a SET FEATURES subcommand Enable/Disable the Sense Data Reporting feature set (see 7.50.17), to the device . The host may disable this capability by issuing a SET FEATURES subcommand Enable/Disable the Sense Data Reporting feature set (see 7.50.17), to the device.

If sense data reporting has been enabled (see 7.50.17), then the device notifies the host of additional information by setting the Sense Data Available bit in the Status field to one . The Error field shall comply the requirements in clause 6 . The host retrieves this additional information by issuing a REQUEST SENSE DATA EXT command to the device . The device may set the Sense Data Available bit to one in the Status field and clear the Error bit to zero in the Status field to indicate that the command was successfully processed and there is additional information about the command (e.g., a correctable error occurred).

If the Sense Data Reporting feature set is not enabled, the device may still make this information available through the REQUEST SENSE DATA EXT command.

The device maintains only the most recent sense data . If more than one reportable event has occurred before the host issues a REQUEST SENSE DATA EXT command, then the device shall return the most recent sense data.

The sense data shall be cleared after:

    a)   receiving any reset;
    b)   acceptance of a command other than REQUEST SENSE DATA EXT command that does not read the NCQ Command Error log; or
    c)   completion of a REQUEST SENSE DATA EXT command.

This feature set shall be disabled upon completion of a power cycle (see ATA8-AAM).

4.25 Software Settings Preservation (SSP) feature set

The Software Settings Preservation (SSP) feature set provides a method for an application client to cause a SATA device to retain the settings of some features that are enabled or disabled using a SET FEATURES command after the device has received a COMRESET . If a device supports the SSP feature set, then the feature shall be enabled by default . See SATA 2.6.

The software settings that shall be preserved across COMRESET are listed in table 16 . The device is only required to preserve the indicated software setting if it supports the particular feature/command with which the setting is associated.

Table 16 — Preserved Feature Sets and Settings

Capability	Preserved Setting
INITIALIZE DEVICE PARAMETERS	Obsolete
Security Mode	Preserve the Current Security State as defined in the security state transition diagram (see 4.22.10)
Standby Timer	Preserve the setting for the Standby timer (see 4.19.3)
Read/Write Stream Error Logs	Preserve the contents of these logs (see A.13 and A.18)
Password Attempt Counter	Preserve the value of the Password Attempt Counter (see 4.22.9)
SET MAX ADDRESS (EXT)	Current maximum LBA (see 7.51.2 and 7.52)
Write Cache enable/disable	Enabled or disabled (see 7.50.4)
Transfer Mode	Preserve the PIO, DMA and UDMA transfer mode settings (see 7.50.5)
Advanced Power Mode	Enabled or disabled (see 7.50.6)
Read look-ahead	Enabled or disabled (see 7.50.13)
Release Interrupt	Obsolete
Service Interrupt	Obsolete
Reverting to Power-On Defaults	Enabled or disabled (see 7.50.14)
Multiple Mode	Preserve the block size from the last set multiple mode (see 7.53)
SANITIZE FREEZE LOCK EXT:	The Sanitize Frozen state established by the SANITIZE FREEZE LOCK EXT command (see 4.21)

4.26 Streaming feature set

4.26.1 Streaming feature set overview

The Streaming feature set allows a host to request delivery of data within an allotted time, placing a priority on the time to transfer the data rather than the integrity of the data . While processing commands in the Streaming feature set, devices may process background tasks if the specified command processing time limits for the commands are met . The Streaming feature set only defines commands that use 48-bit addressing.

Devices that implement the Streaming feature set shall implement the GPL feature set and the following commands:

    a)   CONFIGURE STREAM;
    b)   READ STREAM EXT;
    c)   WRITE STREAM EXT;
    d)   READ STREAM DMA EXT; and
    e)   WRITE STREAM DMA EXT.

SET FEATURES Set Maximum Host Interface Sector Times (see 7.50.12) is an optional feature of the Streaming feature set.

The AAM setting may impact in IDENTIFY DEVICE data word 97 (see 7.18.7.51).

Support of the Streaming feature set is indicated in IDENTIFY DEVICE data word 84 bit 4 (see 7.18.7.40).

4.26.2 Streaming commands

4.26.2.1 Streaming command overview

The CONFIGURE STREAM command (see 7.9) is used by a host to define the properties of a stream to assist the device in configuring its caching for best performance . The Stream Identifier (Stream ID) in the CONFIGURE STREAM command is used by the host to specify the number of the stream to which the operating

parameters in the command apply . Up to a total of eight streams may be configured . The Stream ID may be used by the device to configure its resources to support the streaming requirements of the AV content .

A host may use both read stream commands and write stream commands to access any stream .

The CONFIGURE STREAM command Default Command Completion Time Limit (Default CCTL) (see 7.9.3.4) provides a method for a host to set the time limit for a device to process READ STREAM and WRITE STREAM commands . If the host does not use a CONFIGURE STREAM command to set Default CCTL, the host may specify the time limit for command processing with the Command Completion Time Limit (CCTL) in each READ STREAM or WRITE STREAM command, where the time limit is effective for that command only (see 7.38.3.2) . Each stream may be configured with different command completion time limits.

The read stream commands and write stream commands may access all the user data on a device . These commands may be interspersed with commands not in the Streaming feature set, but, if commands not in the Streaming feature set are interspersed with read stream commands and write stream commands, there may be an impact on performance due to the unknown time required to complete the commands not in the Streaming feature set.

The host should send read stream commands and write stream commands specifying a transfer length that is a multiple of the Stream Minimum Request Size indicated in IDENTIFY DEVICE data word 95 (see 7.18.7.49).

4.26.2.2 Flush bit

The Flush bit (Flush) in the write stream commands (see 7.76.3.3) specifies that the device flushes all volatile cache data for the specified stream to the media before command completion . If a host requests flushes at times other than the end of each Allocation Unit (see 7.9.3.5), streaming performance may be degraded . The SET FEATURES command to enable and disable caching (see 7.50.4) may affect caching for commands in the Streaming feature set.

4.26.2.3 Not Sequential bit

The Not Sequential bit (NS) in the read stream commands (see 7.38.3.4) specifies that the next READ STREAM command with the same Stream ID may not start with the next LBA following the last LBA of the previous read stream command.

> NOTE 5 — The NS bit provides information for the device to optimize pre-fetching decisions.

4.26.2.4 Read Continuous bit

The Read Continuous bit (RC) in the read stream commands (see 7.38.3.3) specifies that the device shall transfer the requested amount of data to the host within the time specified by Default CCTL or CCTL even if an error occurs . The data sent to the host by the device in an error condition is vendor specific.

4.26.2.5 Write Continuous bit

The Write Continuous bit (WC) in the write stream commands (see 7.76.3.2) specifies that the device shall transfer the requested amount of data from the host within the time specified by Default CCTL or CCTL even if an error occurs . If the device is unable to resolve an error within the time specified by Default CCTL or CCTL, the erroneous section on the media may be unchanged or may contain undefined data . A future read of this area may not report an error, even though the data is erroneous.

4.26.2.6 Streaming Logs

A device implementing the Streaming feature set shall implement the Read Stream Error Log (see A.13) and the Write Stream Error Log (see A.18) . These logs are accessed by a host via the READ LOG EXT command (see 7.30).

4.27 Trusted Computing feature set

The Trusted Computing feature set provides an interface between a security component embedded in a device and an application client.

The following commands are mandatory for devices implementing the Trusted Computing feature set:

a) TRUSTED SEND;

b)   TRUSTED SEND DMA;
c)   TRUSTED RECEIVE; and
d)   TRUSTED RECEIVE DMA.

The following command is optional for devices implementing the Trusted Computing feature set:

a)   TRUSTED NON-DATA.

The TRUSTED SEND command and the TRUSTED SEND DMA command may be may be used interchangeably . The two commands only differ by the type of data transport protocol used (i.e., PIO Data-Out Command or DMA Command) . Similarly, the TRUSTED RECEIVE command and the TRUSTED RECEIVE DMA command are interchangeable (i.e., PIO Data-In Command or DMA Command).

IDENTIFY DEVICE data word 48 bit 0 (see 7.18.7.16) indicates whether or not this feature set is supported.

The DEVICE CONFIGURATION OVERLAY SET command provides a mechanism to remove support for this feature set.

The data streams and subsequent actions resulting from these commands are defined by the security protocol identified in the command parameters . The definition of Security Protocols, other than Security Protocol 00h, are outside the scope of this standard.

4.28 Write-Read-Verify feature set

The Write-Read-Verify feature set allows a host to control Read After Write behavior in a device.

To enable or disable the feature of Write/Read/Verify, the host may issue a SET FEATURES command (see 7.50.10).

A device may experience a performance degradation when the Write-Read-Verify feature set is enabled.

These commands are affected by this feature:

a)   WRITE DMA;
b)   WRITE DMA EXT;
c)   WRITE DMA FUA EXT;
d)   WRITE FPDMA QUEUED;
e)   WRITE MULTIPLE;
f)   WRITE MULITIPLE EXT;
g)   WRITE MULTIPLE FUA EXT;
h)   WRITE SECTOR(S); and
i)   WRITE SECTOR(S) EXT.

See 7.50.10 for a description of device behavior when this feature set is supported and enabled.

The IDENTIFY DEVICE data or IDENTIFY PACKET DEVICE data shall reflect the supported and enabled or disabled state of this feature set.

When the device's volatile write cache is enabled, the device may report command completion with no error to the host even if the user data is in the device's volatile write cache and not written and verified to the non-volatile media.

If:

a)   the volatile write cache is disabled and any write command is processed by the device;
b)   a forced unit access write command is processed by the device; or
c)   a flush cache command is processed by the device,

then the device shall only report command completion after the user data has been verified.

If the Write-Read-Verify feature set is enabled and the device has not already verified the maximum number of logical sectors configured for this feature set, then after the device has written the logical sectors to the non-volatile media, the device shall read the data from the non-volatile media and verify that there are no errors . A read from the non-volatile media shall be performed before verification . The verification of logical sectors is defined as vendor specific.

If the Write-Read-Verify feature set is disabled, or if the device has already verified the maximum number of logical sectors configured for this feature set, then no verification by this feature set shall be performed after the device has written the sectors to the non-volatile media.

If an unrecoverable error condition is encountered by the device during the write operation, read operation, or verify operation, the device shall set the Device Fault bit (see 6.2.7) to one.

5 ATA protocols

ATA Protocols are described in the transport standards (e.g., ATA8-APT and ATA8-AST) . The protocols listed here shall be implemented by all transports that use ATA8-ACS commands . The following list of protocols are described in ATA8-AAM and the implementation of each protocol is described in the transport standards:

  a) Non-Data Command Protocol;
  b) PIO Data-In Command Protocol;
  c) PIO Data-Out Command Protocol;
  d) DMA Command Protocol;
  e) PACKET command Protocol;
  f) DMA Queued Command Protocol;
  g) Execute Device Diagnostic Command Protocol; and
  h) Device Reset Command Protocol.

6 Normal and Error Output field descriptions

6.1 Overview

Clause 6 describes requirements for all commands . Individual commands may describe additional requirements . The normal outputs (see 9.2) and error outputs (see 9.3) for each command shall include:

    a) a one byte Status field (see 6.2);
    b) a one byte Error field (see 6.3);
    c) a one byte Interrupt Reason field (see 6.4), if required, for certain commands (e.g., PACKET, READ DMA QUEUED, READ DMA QUEUED EXT, WRITE DMA QUEUED, and WRITE DMA QUEUED EXT); and
    d) the Count (see 6.5), SATA Status (see 6.7), and SActive (see 6.6) fields, if required, for certain commands (e.g., the READ FPDMA QUEUED command, Sanitize Device commands, and WRITE FPDMA QUEUED command).

6.2 Status field

6.2.1 Overview

The Status field is one byte, is conveyed as an output from the device to the host, and is defined in table 17.

Table 17 — Status field

Bit	Description
7	Busy (see 6.2.3)
6	Device Ready (see 6.2.8)
5	Device Fault (see 6.2.7)
5	Stream Error (see 6.2.11)
4	Deferred Write Error (see 6.2.6)
3	Data Request (see 6.2.5)
2	Obsolete or Alignment Error (see 6.2.2)
1	Obsolete or Sense Data Available (see 6.2.10)
0	Check Condition (see 6.2.4) or Error (see 6.2.9)

6.2.2 Alignment Error

The Alignment Error bit shall be set to one if:

    a) IDENTIFY DEVICE data word 106 bit 13 (see 7.18.7.56) is set to one;
    b) IDENTIFY DEVICE data word 69 bit 13 (see 7.18.7.30) is set to one;
    c) IDENTIFY DEVICE data word 49 bits (1:0) (see 7.18.7.17) are 01b or 10b; and
    d) the device successfully processes a write command where:
        A) the first byte of data transfer does not begin at the first byte of a physical sector (see IDENTIFY DEVICE data word 209 bits (13:0) (see 7.18.7.76)); or
        B) the last byte of data transfer does not end at the last byte of a physical sector (see IDENTIFY DEVICE data word 209 bits (13:0)).

If an Alignment Error and another error occur during the processing of a write command, then the error is retuned and the Alignment Error is not reported in the Status field . If an Alignment Error occurs, even if it is not reported in the Status field and there is space remaining in the LPS Mis-alignment log, then an entry shall be made in the log.

6.2.3 Busy bit

The Busy bit is transport dependent (see 6.2.12) . Refer to the applicable transport standard for the usage of the Busy bit.

6.2.4 Check Condition bit

The Check Condition bit shall be set to one if the Sense Key field value of the Error field is greater than zero or any Error bit is set to one (see 6.3).

6.2.5 Data Request bit

The Data Request bit is transport dependent (see 6.2.12) . Refer to the appropriate transport standard for the usage of the Data Request bit.

6.2.6 Deferred Write Error bit

The Deferred Write Error bit shall be set to one if an error was detected in a deferred write to the media for a previous WRITE STREAM DMA EXT command (see 7.76) or WRITE STREAM EXT command (see 7.77) . If the Deferred Write Error bit is set to one, then the location of the deferred error is only reported in the Write Stream Error Log (see A.18).

6.2.7 Device Fault bit

If the device enters a condition where continued operation may affect user data integrity (e.g., failure to spin-up without error, or no spares remaining for reallocation), then the device shall set the Device Fault bit to one and no longer accept commands . This condition is only cleared by power cycling the device . Once the Device Fault bit has been cleared to zero it may remain clear until a command that affects user data integrity is received by the device.

6.2.8 Device Ready bit

The Device Ready bit is transport dependent (see 6.2.12) . Refer to the applicable transport standard for the usage of the Device Ready bit.

6.2.9 Error bit

The Error bit shall be set to one if any bit in the Error field (see 6.3) is set to one.

6.2.10 Sense Data Available

The Sense Data Available bit shall be set to one if:

a)   IDENTIFY DEVICE data word 119 bit 6 (see 7.18.7.40) is set to one;
b)   IDENTIFY DEVICE data word 120 bit 6 (see 7.18.7.41) is set to one; and
c)   the device has sense data to report after processing any command.

The Sense Data Available bit is obsolete if:

a)   IDENTIFY DEVICE data word 119 bit 6 (see 7.18.7.40) is cleared to zero; or
b)   IDENTIFY DEVICE data word 120 bit 6 (see 7.18.7.41) is cleared to zero.

6.2.11 Stream Error bit

The Stream Error bit shall be set to one if an error occurred during the processing of a command in the Streaming feature set (see 4.26) and either the Read Continuous (RC) bit is set to one in a READ STREAM command (see 7.38.3.3) or the Write Continuous (WC) bit is set to one in a WRITE STREAM command (see 7.76.3.2) . When the Stream Error bit is set to one, the value returned in the LBA bits (47:0) contains the address of the first logical sector in error, and the Count field contains the number of consecutive logical sectors that may contain errors . If the RC bit is set to one in a READ STREAM command or the WC bit is set to one in a WRITE STREAM command, and the Interface CRC bit, the Uncorrectable Error bit, the ID Not Found bit, the Abort bit, or the Command Completion Time Out bit is set to one in the Error field (see 6.3), then:

a)   the Stream Error bit shall be set to one;
b)   the Error bit shall be cleared to zero; and
c)   the error information (e.g., bits set in the Error field) shall be saved in the appropriate Read Stream Error Log (see A.13) or Write Stream Error log (see A.18).

6.2.12 Transport Dependent (TD)

All bits and fields that are labelled transport dependent are defined in the transport standards.

6.3 Error field

6.3.1 Overview

The Error field is one byte, is conveyed as an output from the device to the host, and is defined in table 18.

Table 18 — Error field

Bit	Description
7:4	Sense Key (see 6.3.12)
7	Interface CRC (see 6.3.10)
6	Uncorrectable Error (see 6.3.13)
5	Obsolete
4	ID Not Found (see 6.3.6)
3	Obsolete
2	Abort (see 6.3.2)
1	End of Media (see 6.3.5)
0	Illegal Length Indicator (see 6.3.7) or Command Completion Time Out (see 6.3.4) or Media Error (see 6.3.11) or Attempted Partial Range Removal (see 6.3.3) or Insufficient NV Cache space (see 6.3.9) or Insufficient LBA Range Entries Remaining (see 6.3.8)

6.3.2 Abort bit

The Abort bit shall be set to one if the device aborted the command . The Abort bit shall be cleared to zero if the device did not abort the command.

The Abort bit is set to one when the device does not set the ID Not Found bit to one when a a user addressable address was not found or the host request an address outside of the range of user addressable addresses (see 4.12.4 and 6.3.6).

6.3.3 Attempted Partial Range Removal bit

The Attempted Partial Range Removal bit shall be set to one if the REMOVE LBA(S) FROM NV CACHE PINNED SET command (see 7.22.9) attempted to unpin part of a previously defined NV Cache command range.

6.3.4 Command Completion Time Out bit

The Command Completion Time Out bit shall be set to one if a Command Completion Time Out error has occurred (see 4.26).

6.3.5 End of Media bit

The operation of the End of Media bit is specific to the SCSI command set implemented by ATAPI devices.

6.3.6 ID Not Found bit

The ID Not Found bit shall be set to one if:

    a) a user-addressable address was not found; or
    b) an address outside of the range of user-addressable addresses is requested, and the Abort bit is not set
        to one (see 4.12.4 and 6.3.2).

6.3.7 Illegal Length Indicator bit

The operation of the Illegal Length Indicator bit is specific to the SCSI command set implemented by ATAPI devices.

6.3.8 Insufficient LBA Range Entries Remaining bit

The Insufficient LBA Range Entries Remaining bit shall be set to one if the device has run out of space to store LBA ranges for ADD LBA(S) TO NV CACHE PINNED SET command (see 7.22.3).

6.3.9 Insufficient NV Cache Space bit

The Insufficient NV Cache Space bit shall be set to one if there is not enough NV Cache to satisfy the ADD LBA(S) TO NV CACHE PINNED SET command (see 7.22.3).

6.3.10 Interface CRC bit

The Interface CRC bit shall be set to one if an interface CRC error has occurred during an Ultra DMA data transfer . The content of the Interface CRC bit may be applicable to Multiword DMA and PIO data transfers . If the Interface CRC is set to one, the Abort bit shall be set to one.

6.3.11 Media Error bit

The Media Error bit shall be set to one if a media error is detected.

6.3.12 Sense Key field

The operation of this four bit field is specific to the SCSI command set implemented by ATAPI devices.

6.3.13 Uncorrectable Error bit

The Uncorrectable Error bit shall be set to one if the data contains an uncorrectable error.

6.4 Interrupt Reason field

6.4.1 Overview

The Interrupt Reason field is one byte, is conveyed as an output from the device to the host for commands in the PACKET feature set and NCQ feature set, and is defined in table 19.

Table 19 — Interrupt Reason Field

Bit	Description
7:2	Obsolete
1	Input/Output (see 6.4.3)
0	Command/Data (see 6.4.2)

6.4.2 Command/Data bit

The Command/Data bit shall be cleared to zero if the transfer is data, otherwise the Command/Data bit shall be set to one.

6.4.3 Input/Output (I/O) bit

The Input/Output bit shall be cleared to zero if the transfer is to the device . The Input/Output bit shall be set to one if the transfer is to the host.

6.5 Count field

6.5.1 overview

The Count field is one byte, is conveyed as an output from the device to the host, and is defined in table 20.

Table 20 — Count field

Bit	Description
7:3	NCQ Tag (see 6.5.2)
2:0	Reserved

6.5.2 NCQ Tag field

The NCQ Tag field shall contain the NCQ Tag value for an NCQ command . An NCQ Tag value may be any value that does not exceed the value in word 75 in the IDENTIFY DEVICE data (see 7.18.7.33).

6.6 SActive field

See SATA Rev 2.6 for a description of the SActive field.

6.7 SATA Status

See SATA Rev 2.6 for a description of word 0 of the Set Device Bits FIS.

7 Command descriptions

7.1 Command description introduction

7.1.1 Overview

ATA commands are delivered using the following fields:

    a) Feature;
    b) Count;
    c) LBA;
    d) Device; and
    e) Command.

Field lengths change based on the type of command (see 7.1.3).

This standard describes the ATA command set in a transport independent fashion . Each command is defined by a series of subclauses as described in 7.1.2 through 7.1.8.

7.1.2 Command Name - Command Code [/Subcommand Code], Command Protocol

The heading for each command starts with the name of the command . The name is followed by "-" and then the command code, subcommand code if applicable, and protocol used to process the command.

An example heading reads:

READ SECTOR(S) - 20h, PIO Data-In

In this example heading the name of the command is READ SECTOR(S) . The command code is 20h . The protocol used to transfer the data is PIO Data-In.

Protocols are defined in ATA8-AAM . The transport protocol standards define the implementation of each protocol.

7.1.3 Feature Set

The feature set subclause for each command lists the feature set (see clause 4) along with a statement that indicates if the command uses 28-bit field formatting or 48-bit field formatting . If a command uses 28-bit formatting, then:

    a) the Feature field, Count field, Device field, Error field, Status field, and Command field are 8 bits in length; and
    b) the LBA field is 28-bits in length.

If a command uses 48-bit formatting, then:

    a) the Device field, Error field, Status field, and Command field is 8 bits in length;
    b) the Feature field and Count field is 16 bits in length; and
    c) the LBA field is 48-bits in length.

An example feature set subclause reads:

Feature Set

This 28-bit command is for all ATA devices.

7.1.4 Inputs

7.1.4.1 Overview

The Inputs subclause contains a table showing the inputs for the command . An example command structure is shown in table 21.

Table 21 — Example Command Structure

Name	Description
Feature	Each transport standard shows how the Feature field is mapped for proper functionality . Each transport standard also shows how 28-bit commands are mapped differently from 48-bit commands.
Count	Each transport standard shows how the Count field is mapped for proper functionality . Each transport standard also shows how 28-bit commands are mapped differently from 48-bit commands.
LBA	For many commands this is the LBA of the first logical sector to be transferred . Each transport standard defines how these bits are mapped to the appropriate fields or registers.
Device	Each transport standard shows how the Device field bits (7:4) are mapped . Bits (3:0) are marked reserved in every reference to the Device field.
Command	The command number goes here.

7.1.5 Normal Outputs

This is an example Normal Output . A command with Normal Outputs does not return an error . Therefore, the Error field in the Normal Outputs is reserved in every command . The Count field and LBA field may be reserved . In some commands these fields have return parameters on successful command completion . The Status field shows the Device Fault bit and the Error bit . Bit 7, bit 6, and bit 3 are marked Transport Dependent in many of the Normal Outputs.

Table 22 — Example Normal Output

Name	Description
Error	Reserved
Count	Reserved
LBA	Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3:0 Reserved

7.1.6 Error Outputs

The Error Outputs subclause shows the Error field, Count field, LBA field, and Status field . An Error Output occurs when a bit in the Status field (e.g., the Error bit, the Device Fault bit, or the Stream Error bit) is set to one, indicating that an error occurred . If the Error bit is set to one, the Error field indicates the type of Error that occurred.

Table 23 — Example Error Output

Name	Description
Error	**Bit Description** 7 Interface CRC - See 6.3.10 6 Uncorrectable Error - See 6.3.13 5 Obsolete 4 ID Not Found - See 6.3.6 3 Obsolete 2 Abort - See 6.3.2 1 Obsolete 0 Obsolete
Count	Reserved
LBA	LBA of first unrecoverable error
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2:1 N/A 0 Error - See 6.2.9

7.1.7 Input From the Device to the Host Data Structure

Some commands (e.g., IDENTIFY DEVICE command or DEVICE CONFIGURATION IDENTIFY command) return a data structure to the host . This data structure is referred to as an input data structure and is documented following the Error Outputs subclause.

7.1.8 Output From the Host to the Device Data Structure

Some commands, (e.g., DEVICE CONFIGURATION SET command or SECURITY SET PASSWORD command) accept a data structure from the host . This data structure is referred to as an Output Data Structure and is documented following the Error Outputs subclause.

7.1.9 Unsupported commands

The host should not issue commands that are indicated as not supported . If the device receives an unsupported command, then the device shall respond with command aborted as described in table 235.

7.2 CFA ERASE SECTORS - C0h, Non-Data

7.2.1 Feature Set

This 28-bit command is for devices implementing the CFA feature set (see 4.7).

7.2.2 Description

The CFA ERASE SECTORS command causes the device to pre-erase and condition from 1 to 256 logical sectors as specified in the Count field . This command should be issued in advance of a CFA WRITE SECTORS WITHOUT ERASE command or a CFA WRITE MULTIPLE WITHOUT ERASE command to increase the execution speed of the write operation.

7.2.3 Inputs

See table 24 for the CFA ERASE SECTORS command inputs.

Table 24 — CFA ERASE SECTORS command inputs

Name	Description
Feature	N/A
Count	Number of logical sectors to be erased . A value of 00h specifies that 256 logical sectors are to be erased
LBA	LBA of first logical sector to be erased
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 C0h

7.2.4 Normal Outputs

See table 213.

7.2.5 Error Outputs

See table 236.

7.3 CFA REQUEST EXTENDED ERROR CODE - 03h, Non-Data

7.3.1 Feature Set

This 28-bit command is for devices implementing the CFA feature set (see 4.7).

7.3.2 Description

The CFA REQUEST EXTENDED ERROR CODE command returns the extended error code from a previously processed command that identifies the cause of an error condition in more detail than is available with Status field and Error field values . If the previous command completed with an error, then the CFA REQUEST EXTENDED ERROR CODE command shall return an extended error code (see table 26) . If the previous command completed without an error, then the CFA REQUEST EXTENDED ERROR CODE command shall return the No error detected Extended error code (see table 26).

7.3.3 Inputs

See table 25 for the CFA REQUEST EXTENDED ERROR CODE command inputs.

Table 25 — CFA REQUEST EXTENDED ERROR CODE command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 03h

7.3.4 Normal Outputs

See table 214.

Table 26 — Extended error codes (part 1 of 2)

Extended error code	Description
00h	No error detected / no additional information
01h	Self-test passed
02h	Reserved
03h	Write / Erase failed
04h	Reserved
05h	Self-test or diagnostic failed
06h-08h	Reserved
09h	Miscellaneous error
0Ah	Reserved
0Bh	Vendor specific
0Ch	Corrupted media format

Table 26 — Extended error codes (part 2 of 2)

Extended error code	Description
0Dh-0Fh	Vendor specific
10h	ID Not Found / ID Error
11h	Uncorrectable ECC error
12h-13h	Reserved
14h	ID Not Found
15h-17h	Reserved
18h	Corrected ECC error
19h-1Ch	Reserved
1Dh-1Eh	Vendor specific
1Fh	Data transfer error / command aborted
20h	Invalid command
21h	Invalid LBA
22h-23h	Vendor specific
24h-26h	Reserved
27h	Write protect violation
28h-2Eh	Reserved
2Fh	LBA overflow (i.e., address too large)
30h-34h	Self-test or diagnostic failed
35h-36h	Supply or generated voltage out of tolerance
37h	Self-test or diagnostic failed
38h	Corrupted media format
39h	Vendor specific
3Ah	Spare sectors exhausted
3Bh-3Ch	Corrupted media format
3Dh	Vendor specific
3Eh	Self-test or diagnostic failed
3Fh	Corrupted media format
40h-FFh	Reserved

7.3.5 Error Outputs

See table 238.

7.4 CFA TRANSLATE SECTOR - 87h, PIO Data-In

7.4.1 Feature Set

This 28-bit command is mandatory for devices implementing the CFA feature set (see 4.7).

7.4.2 Description

The CFA TRANSLATE SECTOR command returns information related to a specific logical sector . The data indicates the erased or not erased status of the logical sector, and the number of erase and write cycles performed on that logical sector . Devices may return zero in fields that do not apply or that are not supported by the device.

7.4.3 Inputs

See table 27 for the CFA TRANSLATE SECTOR command inputs.

Table 27 — CFA TRANSLATE SECTOR command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	LBA of Logical Sector
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 87h

7.4.4 Normal Outputs

See table 217.

7.4.5 Input From the Device to the Host Data Structure

512 bytes of data are transferred to the host (see table 28).

Table 28 — CFA TRANSLATE SECTOR data

Offset	Description
0..3	Obsolete
4	LBA (23:16)
5	LBA (15:8)
6	LBA (7:0)
7..18	Reserved
19	Logical sector erased flag (FFh = erased; 00h = not erased)
20..23	Reserved
24	Logical sector write cycles count (23:16)
25	Logical sector write cycles count (15:8)
26	Logical sector write cycles count (7:0)
27..511	Reserved

7.4.6 Error Outputs

See table 238.

7.5 CFA WRITE MULTIPLE WITHOUT ERASE - CDh, PIO Data-Out

7.5.1 Feature Set

This 28-bit command is for devices implementing the CFA feature set (see 4.7) .

7.5.2 Description

The CFA WRITE MULTIPLE WITHOUT ERASE command is the same as the WRITE MULTIPLE command (see 7.71) except that the logical sectors are written without an implied erase operation . The logical sectors should be pre-erased by a preceding CFA ERASE SECTORS command.

If bit 8 of IDENTIFY DEVICE data word 59 (see 7.18.7.21) is cleared to zero, and a CFA WRITE MULTIPLE WITHOUT ERASE command is received by the device, and no successful SET MULTIPLE MODE command has been processed by the device, then the device shall return command aborted . A successful SET MULTIPLE MODE command should precede this command.

7.5.3 Inputs

See table 29 for the CFA WRITE MULTIPLE WITHOUT ERASE command inputs.

Table 29 — CFA WRITE MULTIPLE WITHOUT ERASE command inputs

Name	Description
Feature	N/A
Count	Number of logical sectors to be transferred . A value of 00h specifies that 256 logical sectors are to be transferred
LBA	Starting LBA
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 CDh

7.5.4 Normal Outputs

See table 217.

7.5.5 Error Outputs

An unrecoverable error encountered during processing of this command results in command completion with the device returning the LBA of the logical sector where the first unrecovered error occurred . The amount of data transferred is indeterminate . See table 237.

7.6 CFA WRITE SECTORS WITHOUT ERASE - 38h, PIO Data-Out

7.6.1 Feature Set

This 28-bit command is for devices implementing the CFA feature set (see 4.7).

7.6.2 Description

The CFA WRITE SECTORS WITHOUT ERASE command is the same as the WRITE SECTOR(S) command (see 7.74) except that the logical sectors are written without an implied erase operation . The logical sectors should be pre-erased by a preceding CFA ERASE SECTORS command . If the sector is not pre-erased with the CFA ERASE SECTORS command, then a normal write sector operation occurs.

7.6.3 Inputs

See table 30 for the CFA WRITE SECTORS WITHOUT ERASE command inputs.

Table 30 — CFA WRITE SECTORS WITHOUT ERASE command inputs

Name	Description
Feature	N/A
Count	Number of logical sectors to be transferred . A value of 00h specifies that 256 logical sectors are to be transferred
LBA	Starting LBA
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 38h

7.6.4 Normal Outputs

See table 217.

7.6.5 Error Outputs

An unrecoverable error encountered during processing of this command results in command completion with the device returning the LBA of the logical sector where the first unrecovered error occurred . The amount of data transferred is indeterminate . See table 237.

7.7 CHECK MEDIA CARD TYPE - D1h, Non-Data

7.7.1 Feature Set

This 28-bit command is for devices implementing the Media Card Pass Through Command feature set (see 4.15).

7.7.2 Description

The CHECK MEDIA CARD TYPE command reports if the device supports the Media Card Pass Through Command feature set . If the Enable bit in the Feature field is set to one, IDENTIFY DEVICE data word 87 bit 3 (see 7.18.7.41) shall be set to one upon successful command completion .

If the adapter supports the Media Card Pass Through Command feature set and the Enable bit of the Feature field is set to one, the adapter shall process any further Media Card Pass Through Command feature set commands . If the Enable bit is cleared to zero, then the adapter shall not interpret the command codes D2h through D4h as the Media Card Pass Through Command feature set commands.

If the adapter does not support the Media Card Pass Through Command feature set, or the host has disabled the Media Card Pass Through Command feature set mode by clearing the Enable bit to zero, then the host should not send any further Media Card Pass Through Command feature set commands to the adapter.

7.7.3 Inputs

See table 31 for the CHECK MEDIA CARD TYPE command inputs.

Table 31 — CHECK MEDIA CARD TYPE command inputs

Name	Description
Feature	**Bit Description** 15:1 N/A 0 Enable - Shall be set to one to enable the Media Card Pass Through Command feature set . Enable shall be cleared to zero to disable the Media Card Pass Through Command feature set.
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 D1h

7.7.4 Normal Outputs

See table 218.

7.7.5 Error Outputs

See table 239.

7.8 CHECK POWER MODE - E5h, Non-Data

7.8.1 Feature Set

This 28-bit command is for ATA devices that implement the Power Management feature set (see 4.19) . This command is mandatory for ATAPI devices when the Power Management feature set is not implemented in the command set transmitted via the PACKET command.

7.8.2 Description

The CHECK POWER MODE command allows the host to determine the current power mode of the device . The CHECK POWER MODE command shall not cause the device to change its power management state or affect the operation of the Standby timer.

> NOTE 6 — The device may be in transition to the reported state.

7.8.3 Inputs

See table 32 for the CHECK POWER MODE command inputs.

Table 32 — CHECK POWER MODE command inputs.

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 E5h

7.8.4 Normal Outputs

See table 219.

7.8.5 Error Outputs

See table 238.

7.9 CONFIGURE STREAM - 51h, Non-Data

7.9.1 Feature Set

This 48-bit command is for devices that implement the Streaming feature set (see 4.26).

7.9.2 Description

The CONFIGURE STREAM command specifies the operating parameters for a stream . A CONFIGURE STREAM command may be issued for each stream that is to be added or removed from the current operating configuration.

7.9.3 Inputs

7.9.3.1 Overview

See table 33 for the CONFIGURE STREAM command inputs.

Table 33 — CONFIGURE STREAM command inputs

Name	Description
Feature	**Bit Description** 15:8 Default Command Completion Time Limit (Default CCTL) - See 7.9.3.4. 7 Add/Remove Stream (A/R) – See 7.9.3.2. 6 Obsolete 5:3 Reserved 2:0 Stream ID - See 7.9.3.3.
Count	Allocation Unit – See 7.9.3.5
LBA	Reserved
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 51h

7.9.3.2 Add/Remove Stream (A/R)

If A/R is set to one (i.e., the application client is adding a stream), then the device shall set the operating parameters for the stream as specified by this command . If the Stream ID was specified by a previous CONFIGURE STREAM command, and the current CONFIGURE STREAM command completes without error, then the operating parameters specified by the current CONFIGURE STREAM command shall replace the operating parameters specified by the previous CONFIGURE STREAM command for the stream.

If A/R is cleared to zero (i.e., the application client is removing a stream), then the device shall clear the operating characteristics for the Stream ID specified by this command and the Default Command Completion Time Limit field is Reserved.

7.9.3.3 Stream Identifier (Stream ID)

The Stream ID specifies the stream to which the operating parameters apply.

7.9.3.4 Default Command Completion Time Limit (Default CCTL)

The Default CCTL field indicates the time in which the device shall report command completion for a read stream command or a write stream command for this stream with the CCTL field cleared to zero (see 7.38.3.2) according to the following formula:

 maximum command completion time = (Default CCTL * (IDENTIFY DEVICE data words (99:98)) microseconds

The device shall measure the time from command acceptance to command completion.

7.9.3.5 Allocation Unit

The Allocation Unit specifies the number of logical blocks that the device should use for read look-ahead and write cache operations for the stream being configured.

> NOTE 7 — Setting the Allocation Unit does not restrict or change command behavior.

7.9.4 Normal Outputs

See table 220.

7.9.5 Error Outputs

The Abort bit shall be set to one if any of the following are true:

    a)   The device does not support the requested stream configuration;
    b)   A/R is cleared to zero and the Feature field contains a Stream ID that has not been sent in a previous CONFIGURE STREAM command; or
    c)   The device does not support the requested Default CCTL.

If the Abort bit is set to one, then the last parameters specified for the Stream ID shall remain in effect . See table 244 for the definition of Error Outputs.

7.10 DATA SET MANAGEMENT - 06h, DMA

7.10.1 Feature Set

This 48-bit command is optional for ATA devices and prohibited for ATAPI devices . The DATA SET MANAGEMENT command is not part of any feature set.

7.10.2 Description

The DATA SET MANAGEMENT command provides information for device optimization (e.g., file system information).

7.10.3 Inputs

7.10.3.1 Overview

See table 34 for the DATA SET MANAGEMENT command inputs.

Table 34 — DATA SET MANAGEMENT command inputs

Name	Description
Feature	**Bit Description** 15:1 Reserved. 0 Trim - See 7.10.3.2.
Count	Number of 512-byte blocks to be transferred (see 7.10.6) . The value of zero is reserved.
LBA	Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 06h

7.10.3.2 Trim

If the Trim bit is set to one, then a trim operation is being requested on the data in the logical block ranges addressed by the DATA SET MANAGEMENT command's output data . shall: Until a subsequent write command to a logical block that has been trimmed successfully completes, if the data from that logical block address is read, then the data is returned as described in table 35.

Table 35 shows the interactions of IDENTIFY DEVICE data word 169 bit 0 (see 7.18.7.71), IDENTIFY DEVICE data word 69 bit 14 (see 7.18.7.30), and IDENTIFY DEVICE data word 69 bit 5 (see 7.18.7.30).

Table 35 — TRIM related interactions

Word 169 bit 0	Word 69 bit 14	Word 69 bit 5	Description
0	Reserved	Reserved	The Trim function of the DATA SET MANAGEMENT command (see 7.10.3.2) is not supported . The data is unaffected by this command.
1	0	Reserved	The Trim function of the DATA SET MANAGEMENT command (see 7.10.3.2) shall cause indeterminate read after trim behavior [a].
1	1	0	The Trim function of the DATA SET MANAGEMENT command (see 7.10.3.2) shall cause deterministic read after trim behavior [b] with words set to any value.
1	1	1	The Trim function of the DATA SET MANAGEMENT command (see 7.10.3.2) shall cause deterministic read after trim behavior [b] with words set to zero.
[a] Indeterminate read after trim behavior: each read command to the logical block may return different data.			
[b] Determinate read after trim behavior: after a read command has completed processing, the data in that logical block becomes determinate (i.e., all read commands to the logical block shall return the same data).			

The data read from an LBA that has been trimmed shall not be retrieved from data that was previously received from an application client addressed to any other LBA.

Once a trimmed LBA has been written (e.g., a write command or a SECURITY ERASE UNIT command), the data in that logical block becomes determinate (i.e., the logical block contains the written data).

Trim shall not add or remove logical blocks from the NV Cache Pinned Set.

7.10.4 Normal Outputs

See table 227.

7.10.5 Error Outputs

If the Trim bit is set to one and:

    a) the device detects an invalid LBA Range entry; or
    b) count is greater than IDENTIFY DEVICE data word 105 (see 7.18.7.55),

then the device shall return command aborted.

A device may trim one or more LBA Range Entries before it returns command aborted . See table 253.

7.10.6 Output From the Host to the Device Data Structure

DATA SET MANAGEMENT Request Data is a list of one or more LBA Range Entries (see 4.17.3.2) . If the Trim bit is set to one, then LBA Range Entries may overlap and are not required to be sorted . See table 73.

7.11 Device Configuration Overlay (DCO)

7.11.1 DCO Overview

Individual DCO feature set (see 4.8) commands are identified by the value placed in the Feature field (see table 36).

Table 36 — Device Configuration Overlay Feature field values

Value	Commands
00h..BFh	Reserved
C0h	DEVICE CONFIGURATION RESTORE (see 7.11.5)
C1h	DEVICE CONFIGURATION FREEZE LOCK (see 7.11.2)
C2h	DEVICE CONFIGURATION IDENTIFY (see 7.11.3)
C3h	DEVICE CONFIGURATION SET (see 7.11.6)
C4h	DEVICE CONFIGURATION IDENTIFY DMA (see 7.11.4)
C5h	DEVICE CONFIGURATION SET DMA (see 7.11.7)
C6h..FFh	Reserved

7.11.2 DEVICE CONFIGURATION FREEZE LOCK - B1h/C1h, Non-Data

7.11.2.1 Feature Set

This 28-bit command is for devices implementing the DCO feature set (see 4.8).

7.11.2.2 Description

The DEVICE CONFIGURATION FREEZE LOCK command provides a method for the host to prevent accidental modification of a device's DCO settings . After a device has completed a DEVICE CONFIGURATION FREEZE LOCK command without error, the device shall return command aborted for all DEVICE CONFIGURATION SET command, DEVICE CONFIGURATION FREEZE LOCK command, DEVICE CONFIGURATION IDENTIFY command, and DEVICE CONFIGURATION RESTORE command until after the device processes a power-on reset . A device shall be in the factory_config state or the reduced_config state (see figure 4) after processing a power-on reset . A device shall not exit the DCO_Locked state as the result of processing a hardware reset or a software reset.

7.11.2.3 Inputs

See table 37 for the DEVICE CONFIGURATION FREEZE LOCK command inputs.

Table 37 — DEVICE CONFIGURATION FREEZE LOCK command inputs

Name	Description
Feature	C1h
Count	N/A
LBA	N/A
Device	**Bit Description** 7:5 N/A 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B1h

7.11.2.4 Normal Outputs

See table 215.

7.11.2.5 Error Outputs

The Abort bit shall be set to one if the device has completed a previous DEVICE CONFIGURATION FREEZE LOCK command without error since processing the most recent power-on reset . See table 239.

7.11.3 DEVICE CONFIGURATION IDENTIFY - B1h/C2h, PIO Data-In

7.11.3.1 Feature Set

This 28-bit command is for devices implementing the DCO feature set (see 4.8).

7.11.3.2 Description

The DEVICE CONFIGURATION IDENTIFY command requires a device to return a 512-byte data structure . The content of this data structure indicates the selectable commands, modes, and feature sets that the device is capable of disabling or modifying through processing of a DEVICE CONFIGURATION SET command . If a DEVICE CONFIGURATION SET command reducing a device's capabilities has completed without error, then:

   a) the response by a device to commands other than the DEVICE CONFIGURATION IDENTIFY command, shall reflect the reduced set of capabilities; and
   b) the response by a device to a DEVICE CONFIGURATION IDENTIFY command shall reflect the entire set of selectable capabilities.

The phrase "is changeable" used in 7.11.3 indicates that the feature may be disabled by the host using a DEVICE CONFIGURATION SET command (see 7.11.6).

If the feature is not changeable, then the device may support the feature but the DEVICE CONFIGURATION SET command shall not affect support of the feature.

The format of the Device Configuration Overlay data structure is shown in table 39.

7.11.3.3 Inputs

See table 38 for the DEVICE CONFIGURATION IDENTIFY command inputs.

Table 38 — DEVICE CONFIGURATION IDENTIFY command inputs

Name	Description
Feature	C2h
Count	N/A
LBA	N/A
Device	**Bit Description** 7:5 N/A 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B1h

7.11.3.4 Normal Outputs

See table 215.

7.11.3.5 Error Outputs

A device shall return command aborted if the device has completed a DEVICE CONFIGURATION FREEZE LOCK command without error since processing the most recent power-on reset . A device may return command completion with the Error bit set to one if an Interface CRC error has occurred . See table 240.

> NOTE 8 — There is no defined mechanism for a device to return an Interface CRC error status that may have occurred during the last data block of a PIO-in data transfer . There may be other mecha-nisms in which a host may verify that an Interface CRC error occurred in these cases.

7.11.3.6 Input From the Device to the Host Data Structure

7.11.3.6.1 Overview

Table 39 — Device Configuration Identify data structure (part 1 of 2)

Word	Description
0	Data structure revision
1	Multiword DMA modes supported
	15:3 Reserved
	2 1 = Reporting support for Multiword DMA mode 2 and below is changeable
	1 1 = Reporting support for Multiword DMA mode 1 and below is changeable
	0 1 = Reporting support for Multiword DMA mode 0 is changeable
2	Ultra DMA modes supported
	15:7 Reserved
	6 1 = Reporting support for Ultra DMA mode 6 and below is changeable
	5 1 = Reporting support for Ultra DMA mode 5 and below is changeable
	4 1 = Reporting support for Ultra DMA mode 4 and below is changeable
	3 1 = Reporting support for Ultra DMA mode 3 and below is changeable
	2 1 = Reporting support for Ultra DMA mode 2 and below is changeable
	1 1 = Reporting support for Ultra DMA mode 1 and below is changeable
	0 1 = Reporting support for Ultra DMA mode 0 is changeable
3..6	Maximum LBA (QWord)
	63:48 Reserved
	47:0 Maximum LBA
7	Command set/feature set supported part 1
	15 Reserved
	14 1 = Reporting support for the Write-Read-Verify feature set is changeable
	13 1 = Reporting support for the SMART Conveyance self-test is changeable
	12 1 = Reporting support for the SMART Selective self-test is changeable
	11 1 = Reporting support for the Forced Unit Access is changeable
	10 Reserved for TLC
	9 1 = Reporting support for the Streaming feature set is changeable
	8 1 = Reporting support for the 48-bit Addressing feature set is changeable
	7 1 = Reporting support for the HPA feature set is changeable
	6 1 = Reporting support for the AAM feature set is changeable
	5 This field is obsolete.
	4 1 = Reporting support for the PUIS feature set is changeable
	3 1 = Reporting support for the Security feature set is changeable
	2 1 = Reporting support for the SMART error log is changeable
	1 1 = Reporting support for the SMART self-test is changeable
	0 1 = Reporting support for the SMART feature set is changeable

Table 39 — Device Configuration Identify data structure (part 2 of 2)

Word	Description
8	Serial ATA Command set/feature set supported
	15:5 Reserved for Serial ATA
	4 1 = Reporting support for the SSP feature set is changeable
	3 1 = Reporting support for asynchronous notification is changeable
	2 1 = Reporting support for interface power management is changeable
	1 1 = Reporting support for non-zero buffer offsets is changeable
	0 1 = Reporting support for the NCQ feature set is changeable
9	Reserved for Serial ATA
10..20	Reserved
21	Command set/feature set supported part 2
	15 1 = Reporting support for the NV Cache feature set is changeable
	14 1 = Reporting support for the NV Cache Power Management feature set is changeable
	13 1 = Reporting support for WRITE UNCORRECTABLE EXT is changeable
	12 1 = Reporting of support for the Trusted Computing feature set is changeable
	11 1 = Reporting support for the Free-fall Control feature set is changeable
	10 1 = Reporting support for the DATA SET MANAGEMENT command is changeable
	9 1 = Reporting support for Extended Power Conditions is changeable
	8:0 Reserved
22	Command set/feature set supported part 3
	15:0 Reserved
23..207	Reserved
208..254	Vendor Specific
255	Integrity word
	15:8 Checksum
	7:0 A5h

7.11.3.6.2 Word 0: Data structure revision

Word 0 shall contain the value 0002h.

7.11.3.6.3 Word 1: Multiword DMA modes supported

Word 1 bits (2:0) contain the same information as contained in IDENTIFY DEVICE data word 63 (see 7.18.7.24) or IDENTIFY PACKET DEVICE data word 63 (see 7.19.6.18) . Bits (15:3) of word 1 are reserved.

7.11.3.6.4 Word 2: Ultra DMA modes supported

Word 2 bits (6:0) contain the same information as contained in IDENTIFY DEVICE data word 88 (see 7.18.7.42) or IDENTIFY PACKET DEVICE data word 88 (see 7.19.6.36) . Bits (15:7) of word 2 are reserved.

7.11.3.6.5 Words 3..6: Maximum LBA

Words 3..6 define the maximum LBA (i.e., the highest LBA accepted by the device in the factory default condition) . If the device is in the:

    a)   DCO2:Reduced_config state or DCO1:DCO_locked state; and
    b)   has a reduced Maximum LBA,

then the native max address is less than the Maximum LBA reported by DEVICE CONFIGURATION IDENITFY command.

7.11.3.6.6 Word 7: Command/features set supported part 1

If bit 0 of Word 7 is set to one, then support for the SMART feature set is changeable.

If bit 1 of Word 7 is set to one, then support for SMART self-test including the self-test log is changeable.

If bit 2 of Word 7 is set to one, then support for SMART error logging is changeable.

If bit 3 of Word 7 is set to one, then support for the Security feature set is changeable.

If bit 4 of Word 7 is set to one, then support for the PUIS feature set is changeable.

Bit 5 of Word 7 is obsolete.

If bit 6 of Word 7 is set to one, then support for the AAM feature set is changeable.

If bit 7 of Word 7 is set to one, then support for the HPA feature set is changeable.

If bit 8 of Word 7 is set to one, then support for the 48-bit Addressing feature set is changeable.

If bit 9 of Word 7 is set to one, then support for the Streaming feature set is changeable .

Bit 10 of Word 7 is reserved for technical report TLC.

If bit 11 of Word 7 is set to one, then support for Force Unit Access commands is changeable.

If bit 12 of Word 7 is set to one, then support for SMART Selective self-test (see 7.55.6.10) is changeable.

If bit 13 of Word 7 is set to one, then support for SMART Conveyance self-test (see 7.55.6.10) is changeable.

If bit 14 of Word 7 is set to one, then support for the Write-Read-Verify feature set is changeable.

7.11.3.6.7 Word 8: Serial ATA Command set/feature set supported

Bits (15:5) Reserved for Serial ATA

If bit 4 of Word 8 is set to one, then support for software settings preservation is changeable.

If bit 3 of Word 8 is set to one, then support for asynchronous notification by an ATAPI device is changeable . See SATA 2.6 for more information.

If bit 2 of Word 8 is set to one, then support for interface power management requests is changeable . See SATA 2.6 for more information.

If bit 1 of Word 8 is set to one, then support for non-zero buffer offsets for commands in the NCQ feature set is changeable.

If bit 0 of Word 8 is set to one, then support for the NCQ feature set is changeable.

7.11.3.6.8 Word 9: Reserved for Serial ATA

This word is reserved for Serial ATA.

7.11.3.6.9 Words 10..20: Reserved

7.11.3.6.10 Word 21: Command/features set supported part 2

If bit 15 of Word 21 is set to one, then support for the NV Cache feature set is changeable.

If bit 14 of Word 21 is set to one, then support for the NV Cache Power Management feature set is changeable.

If bit 13 of Word 21 is set to one, then support for the WRITE UNCORRECTABLE EXT command (see 7.78) is changeable.

If bit 12 of Word 21 is set to one, then support for the Trusted Computing feature set is changeable.

If bit 11 of Word 21 is set to one, then support for the Free-fall Control feature set is changeable.

If bit 10 of Word 21 is set to one, then support for the DATA SET MANAGEMENT command (see 7.10) is changeable.

If bit 9 of Word 21 is set to one, then support for the Extended Power Conditions feature set is changeable.

Bits 8:0 of Word 21 are reserved.

7.11.3.6.11 Word 22: Command/features set supported part 3

Bits (15:0) are reserved.

7.11.3.6.12 Words 23..207: Reserved

7.11.3.6.13 Words 208..254: Vendor Specific

7.11.3.6.14 Word 255: Integrity word

Bits (7:0) of this word shall contain the value A5h . Bits (15:8) of this word shall contain the data structure checksum . The data structure checksum shall be the two's complement of the sum of all bytes in words 0..254 and the byte consisting of bits (7:0) of word 255 . Each byte shall be added with unsigned arithmetic, and overflow shall be ignored . The sum of all bytes is zero when the checksum is correct.

7.11.4 DEVICE CONFIGURATION IDENTIFY DMA - B1h/C4h, DMA

7.11.4.1 Feature Set

This 28-bit command is for devices implementing the DCO feature set (see 4.8).

7.11.4.2 Description

See 7.11.3.2.

7.11.4.3 Inputs

See table 40 for the DEVICE CONFIGURATION IDENTIFY DMA command inputs.

Table 40 — DEVICE CONFIGURATION IDENTIFY DMA command inputs.

Name	Description
Feature	C4h
Count	N/A
LBA	N/A
Device	**Bit Description** 7:5 N/A 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B1h

7.11.4.4 Normal Outputs

See 7.11.3.4.

7.11.4.5 Error Outputs

See 7.11.3.5.

7.11.4.6 Input From the Device to the Host Data Structure

See 7.11.3.6.

7.11.5 DEVICE CONFIGURATION RESTORE - B1h/C0h, Non-Data

7.11.5.1 Feature Set

This 28-bit command is for devices implementing the DCO feature set (see 4.8).

7.11.5.2 Description

The DEVICE CONFIGURATION RESTORE command restores to their factory default settings, any setting previously changed by a DEVICE CONFIGURATION SET command (see 7.11.6) . The results of this action are indicated by the data returned from the Input Data of a DEVICE CONFIGURATION IDENTIFY command (see 7.11.3).

If a DEVICE CONFIGURATION RESTORE command changes reporting of support for the Security feature set from not allowed to allowed, and the DEVICE CONFIGURATION IDENTIFY command indicates that reporting of that support is allowed, then he device shall:

- a) set the Security feature set state to SEC1 (see figure 16);
- b) set IDENTIFY DEVICE data to the values described in table 11; and
- c) restore the saved Master password and Master Password Identifier,

otherwise, the Security state shall not change.

If a DEVICE CONFIGURATION RESTORE command changes reporting of support for the EPC feature set from not supported to supported, then the device shall:

- a) set IDENTIFY DEVICE data word 119 bit 7 (see 7.18.7.40) to one;
- b) change the Log Directory to indicate that the Power Conditions log is supported; and
- c) initialize the Power Conditions log such that the Default, Saved and Current settings match for all power conditions.

7.11.5.3 Inputs

See table 41 for the DEVICE CONFIGURATION RESTORE command inputs.

Table 41 — DEVICE CONFIGURATION RESTORE command inputs.

Name	Description
Feature	C0h
Count	N/A
LBA	N/A
Device	**Bit Description** 7:5 N/A 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B1h

7.11.5.4 Normal Outputs

See table 215.

7.11.5.5 Error Outputs

The Abort bit shall be set to one if a HPA has been set by a non-volatile SET MAX ADDRESS command or SET MAX ADDRESS EXT command, or if DEVICE CONFIGURATION FREEZE LOCK command has been completed without error since a power-on reset has been processed . See table 239.

7.11.6 DEVICE CONFIGURATION SET - B1h/C3h, PIO Data-Out

7.11.6.1 Feature Set

This 28-bit command is for devices implementing the DCO feature set (see 4.8).

7.11.6.2 Description

The DEVICE CONFIGURATION SET command reduces the set of optional commands, modes, or feature sets supported by a device as indicated by a DEVICE CONFIGURATION IDENTIFY command . The DEVICE CONFIGURATION SET command may modify the data returned by the IDENTIFY DEVICE command or IDENTIFY PACKET DEVICE command . When the IDENTIFY DEVICE data or the IDENTIFY PACKET DEVICE data is changed, the device shall respond in a manner consistent with the new data.

If a bit is set to one in the DEVICE CONFIGURATION SET data transmitted to the device (see table 43) that is not set in the data received from a DEVICE CONFIGURATION IDENTIFY command (see table 39), then no action is taken for that bit.

Modifying the maximum LBA of the device also modifies the LBA value returned by a READ NATIVE MAX ADDRESS command or READ NATIVE MAX ADDRESS EXT command.

The format of the DEVICE CONFIGURATION SET data transmitted by the device is described in table 43 . (see 7.11.6.6) for the restrictions on changing these bits.

The phrase "is allowed" in table 43 specifies that the device may report that a feature is supported.

If the device is configured to not support a feature, then the device shall:

    a) report that the feature is not supported;
    b) as required, report that the feature is not enabled; and
    c) not support the feature.

7.11.6.3 Inputs

See table 42 for the DEVICE CONFIGURATION SET command inputs.

Table 42 — DEVICE CONFIGURATION SET command inputs

Name	Description
Feature	C3h
Count	N/A
LBA	N/A
Device	**Bit Description** 7:5 N/A 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B1h

7.11.6.4 Normal Outputs

See table 215.

7.11.6.5 Error Outputs

The Abort bit shall be set to one and the data returned by the IDENTIFY DEVICE command and IDENTIFY PACKET DEVICE command shall not be changed as a result of the failed DEVICE CONFIGURATION SET command if:

    a) a DEVICE CONFIGURATION SET command has already modified the original settings as reported by a
        DEVICE CONFIGURATION IDENTIFY command;

b) a DEVICE CONFIGURATION FREEZE LOCK command has completed without error;
c) any of the bit modification restrictions described in 7.11.6.2 are violated;
d) an HPA has been established by the processing of a SET MAX ADDRESS command or SET MAX ADDRESS EXT command; or
e) an attempt was made to modify a mode or feature that shall not be modified with the device in its current state.

See table 257.

7.11.6.6 Output From the Host to the Device Data Structure

7.11.6.6.1 Overview

Table 43 — Device Configuration Overlay (DCO) data structure (part 1 of 3)

Word	Description
0	Data structure revision
1	Multiword DMA modes supported
	15:3 Reserved
	2 1 = Reporting support for Multiword DMA mode 2 and below is allowed
	1 1 = Reporting support for Multiword DMA mode 1 and below is allowed
	0 1 = Reporting support for Multiword DMA mode 0 is allowed
2	Ultra DMA modes supported
	15:7 Reserved
	6 1 = Reporting support for Ultra DMA mode 6 and below is allowed
	5 1 = Reporting support for Ultra DMA mode 5 and below is allowed
	4 1 = Reporting support for Ultra DMA mode 4 and below is allowed
	3 1 = Reporting support for Ultra DMA mode 3 and below is allowed
	2 1 = Reporting support for Ultra DMA mode 2 and below is allowed
	1 1 = Reporting support for Ultra DMA mode 1 and below is allowed
	0 1 = Reporting support for Ultra DMA mode 0 is allowed
3..6	Maximum LBA (QWord)
	63:48 Reserved
	47:0 Maximum LBA
Note - The phrase "is allowed" specifies that the device may report that a feature is supported	

Table 43 — Device Configuration Overlay (DCO) data structure (part 2 of 3)

Word	Description
7	Command set/feature set supported part 1
	15 Reserved
	14 1 = Reporting support for the Write-Read-Verify feature set is allowed
	13 1 = Reporting support for the SMART Conveyance self-test is allowed
	12 1 = Reporting support for the SMART Selective self-test is allowed
	11 1 = Reporting support for Forced Unit Access is allowed
	10 Reserved for TLC
	9 1 = Reporting support for the Streaming feature set is allowed
	8 1 = Reporting support for the 48-bit Addressing feature set is allowed
	7 1 = Reporting support for HPA feature set is allowed
	6 1 = Reporting support for the AAM feature set is allowed
	5 This field is obsolete
	4 1 = Reporting support for the PUIS feature set is allowed
	3 1 = Reporting support for the Security feature set is allowed
	2 1 = Reporting support for the SMART error log is allowed
	1 1 = Reporting support for the SMART self-test is allowed
	0 1 = Reporting support for the SMART feature set is allowed
8	Serial ATA Command set/feature set supported
	15:5 Reserved for Serial ATA
	4 1 = Reporting support for the SSP feature set is allowed
	3 1 = Reporting support for asynchronous notification is allowed
	2 1 = Reporting support for interface power management is allowed
	1 1 = Reporting support for non-zero buffer offsets is allowed
	0 1 = Reporting support for the NCQ feature set is allowed
9	Reserved for Serial ATA
10..20	Reserved
21	Command set/feature set supported part 2
	15 Reporting support for the NV Cache feature set is allowed
	14 Reporting support for the NV Cache Power Management feature set is allowed
	13 1= Reporting support for the WRITE UNCORRECTABLE EXT command is allowed
	12 1= reporting of support for the Trusted Computing feature set is allowed
	11 1 = Reporting support for the Free-fall Control feature set is allowed
	10 1 = Reporting support for the DATA SET MANAGEMENT command is allowed
	9 1 = Reporting support for Extended Power Conditions is allowed
	8:0 Reserved
22	Command set/feature set supported part 3
	15:0 Reserved
23..207	Reserved
208..254	Vendor Specific
Note - The phrase "is allowed" specifies that the device may report that a feature is supported	

Table 43 — Device Configuration Overlay (DCO) data structure (part 3 of 3)

Word	Description
255	Integrity word 15:8 Checksum 7:0 A5h
Note - The phrase "is allowed" specifies that the device may report that a feature is supported	

7.11.6.6.2 Word 0: Data structure revision

Word 0 shall contain the value 0002h.

7.11.6.6.3 Word 1: Multiword DMA modes supported

Bits (15:3) of word 1 are reserved.

If Multiword DMA mode 2 is not currently selected and bit 2 of word 1 is cleared to zero, then the device shall:

    a)   disable support for Multiword DMA mode 2; and
    b)   clear IDENTIFY DEVICE data word 63 bit 2 (see 7.18.7.24) to zero or IDENTIFY PACKET DEVICE data word 63 bit 2 (see 7.19.6.18) to zero.

If Multiword DMA mode 2 is currently selected and bit 2 of word 1 is cleared to zero, then the device shall not clear IDENTIFY DEVICE data word 63 bit 2 (see 7.18.7.24) to zero or IDENTIFY PACKET DEVICE data word 63 bit 2 (see 7.19.6.18) to zero.

If Multiword DMA mode 1 is not currently selected and bit 1 of word 1 is cleared to zero, then the device shall:

    a)   disable support for Multiword DMA mode 1; and
    b)   clear IDENTIFY DEVICE data word 63 bit 1 (see 7.18.7.24) to zero or IDENTIFY PACKET DEVICE data word 63 bit 1 (see 7.19.6.18) to zero.

If Multiword DMA mode 2 is supported or Multiword DMA mode 1 or mode 2 is currently selected and bit 1 of word 1 is cleared to zero, then the device shall not clear IDENTIFY DEVICE data word 63 bit 1 (see 7.18.7.24) to zero or IDENTIFY PACKET DEVICE data word 63 bit 1 (see 7.19.6.18) to zero.

Bit 0 of word 1 shall be set to one.

7.11.6.6.4 Word 2: Ultra DMA modes supported

Bits (15:7) of word 2 are reserved.

If Ultra DMA mode 6 is not currently selected and bit 6 of word 2 is cleared to zero, then the device shall:

    a)   disable support for Ultra DMA mode 6; and
    b)   clear IDENTIFY DEVICE data word 88 bit 6 (see 7.18.7.42) to zero or IDENTIFY PACKET DEVICE data word 88 bit 6 (see 7.19.6.36) to zero.

If Ultra DMA mode 6 is currently selected, then the device shall not clear IDENTIFY DEVICE data word 88 bit 6 (see 7.18.7.42) to zero or IDENTIFY PACKET DEVICE data word 88 bit 6 (see 7.19.6.36) to zero.

If bit 5 of word 2 is cleared to zero and:

    a)   Ultra DMA mode 6 and mode 5 are not currently selected; and
    b)   Ultra DMA mode 6 is not supported,

then the device shall clear IDENTIFY DEVICE data word 88 bit 5 (see 7.18.7.42) to zero or IDENTIIFY PACKET DEVICE data word 88 bit 5 (see 7.19.6.36) to zero.

If bit 4 of word 2 is cleared to zero and:

    a)   Ultra DMA mode 6, mode 5 and mode 4 are not currently selected; and
    b)   Ultra DMA mode 6 and mode 5 are not supported,

then the device shall clear IDENTIFY DEVICE data word 88 bit 4 (see 7.18.7.42) to zero or IDENTIIFY PACKET DEVICE data word 88 bit 4 (see 7.19.6.36) to zero.

If bit 3 of word 2 is cleared to zero and:

a) Ultra DMA mode 6, mode 5, mode 4 and mode 3 are not currently selected; and
b) Ultra DMA mode 6, mode 5 and mode 4 are not supported,

then the device shall clear IDENTIFY DEVICE data word 88 bit 3 (see 7.18.7.42) to zero or IDENTIIFY PACKET DEVICE data word 88 bit 3 (see 7.19.6.36) to zero.

If bit 2 of word 2 is cleared to zero and:

a) Ultra DMA mode 6, mode 5, mode 4, mode 3 and mode 2 are not currently selected; and
b) Ultra DMA mode 6, mode 5, mode 4 and mode 3 are not supported,

then the device shall clear IDENTIFY DEVICE data word 88 bit 2 (see 7.18.7.42) to zero or IDENTIIFY PACKET DEVICE data word 88 bit 2 (see 7.19.6.36) to zero..

If bit 1 of word 2 is cleared to zero and:

a) Ultra DMA mode 6, mode 5, mode 4, mode 3, mode 2 and mode 1 are not currently selected; and
b) Ultra DMA mode 6, mode 5, mode 4, mode 3 and mode 2 are not supported,

then the device shall clear IDENTIFY DEVICE data word 88 bit 1 (see 7.18.7.42) to zero or IDENTIIFY PACKET DEVICE data word 88 bit 1 (see 7.19.6.36) to zero.

If bit 0 of word 2 is cleared to zero and:

a) Ultra DMA mode 6, mode 5, mode 4, mode 3, mode 2, mode 1 and mode 0 are not currently selected; and
b) Ultra DMA mode 6, mode 5, mode 4, mode 3, mode 2 and mode 1 are not supported,

then the device shall clear IDENTIFY DEVICE data word 88 bit 0 (see 7.18.7.42) to zero or IDENTIIFY PACKET DEVICE data word 88 bit 0 (see 7.19.6.36) to zero.

7.11.6.6.5 Words 3..6: Maximum LBA

Words 3..6 define the Maximum LBA . This shall be the highest LBA accepted by the device after processing of the command . When Maximum LBA is changed, the content of IDENTIFY DEVICE data words 60..61 (see 7.18.7.22) and IDENTIFY DEVICE data words 100..103 (see 7.18.7.53) shall be changed as described in the SET MAX ADDRESS command and SET MAX ADDRESS EXT command descriptions to reflect the maximum LBA set with this command . If the device has established an HPA as the result of processing a SET MAX ADDRESS command or SET MAX ADDRESS EXT command with an LBA value less than that returned by a READ NATIVE MAX ADDRESS command or READ NATIVE MAX ADDRESS EXT command, then the device shall return command aborted for this command and not change any data in the HPA.

7.11.6.6.6 Word 7: Command/features set supported part 1

Bit 15 of word 7 is reserved.

If bit 14 of word 7 is cleared to zero, then the device shall:

a) disable support for the Write-Read-Verify feature set;
b) clear IDENTIFY DEVICE data word 119 bit 1 (see 7.18.7.40) to zero or IDENTIFY PACKET DEVICE data word 119 bit 1 (see 7.19.6.34) to zero; and
c) clear IDENTIFY DEVICE data word 120 bit 1 (see 7.18.7.41) to zero or IDENTIFY PACKET DEVICE data word 120 bit 1 (see 7.19.6.35) to zero.

If bit 13 of word 7 is cleared to zero, then the device shall:

a) disable support for the SMART Conveyance self-test;
b) return command aborted for subsequent SMART EXECUTE OFF-LINE IMMEDIATE commands with an Execute SMART Conveyance self-test routine subcommand; and
c) clear bit 5 to zero in the Offline Data Collection Capabilities field in the Device SMART data structure.

If bit 12 of word 7 is cleared to zero, then the device shall:

a) disable support for the SMART Selective self-test;

b)   return command aborted for subsequent SMART EXECUTE OFF-LINE IMMEDIATE commands with an Execute SMART Selective self-test routine subcommand; and

c)   clear bit 6 to zero in the Offline Data Collection Capabilities field in the Device SMART data structure.

If bit 11 of word 7 is cleared to zero, then the device shall:

a)   disable support for the WRITE DMA FUA EXT command and the WRITE MULTIPLE FUA EXT command; and

b)   clear IDENTIFY DEVICE data word 84 bits (7:6) (see 7.18.7.40) to zero or IDENTIFY PACKET DEVICE data word 84 bits (7:6) (see 7.19.6.34) to zero.

Bit 10 of Word 7 is reserved for TLC.

If bit 9 of word 7 is cleared to zero, then the device shall:

a)   disable support for the Streaming feature set;

b)   clear IDENTIFY DEVICE data
   A)   word 84 bit 4 to zero;
   B)   word 84 bit 9 to zero; and
   C)   word 84 bit 10 to zero;

c)   clear IDENTIFY DEVICE data words 95..99 (see 7.18.7.49, 7.18.7.50, 7.18.7.51, and 7.18.7.52) to zero; and

d)   clear IDENTIFY DEVICE data word 104 see 7.18.7.54 to zero.

If bit 8 of word 7 is cleared to zero, then the device shall:

a)   disable support for the 48-bit Addressing feature set;

b)   clear IDENTIFY DEVICE data word 83 bit 10 to zero; and

c)   clear IDENTIFY DEVICE data words 100..103 to zero.

If bit 7 of word 7 is cleared to zero, and a HPA has not been established by use of a SET MAX ADDRESS command or SET MAX ADDRESS EXT command, then the device shall:

a)   disable support for the HPA feature set;

b)   clear:
   A)   IDENTIFY DEVICE data:
      a)   word 82 bit 10 to zero;
      b)   word 83 bit 8 to zero;
      c)   word 85 bit 10 to zero; and
      d)   word 86 bit 8 to zero;

      or

   B)   IDENTIFY PACKET DEVICE data:
      a)   word 82 bit 10 to zero;
      b)   word 83 bit 8 to zero;
      c)   word 85 bit 10 to zero; and
      d)   word 86 bit 8 to zero;

If bit 7 of word 7 is cleared to zero, and an HPA has been established by use of a SET MAX ADDRESS command or SET MAX ADDRESS EXT command, then the device shall return command aborted for the DEVICE CONFIGURATION SET command.

If bit 6 of word 7 is cleared to zero, then the device shall:

a)   disable support for the AAM feature set;

b)   clear IDENTIFY DEVICE data word 83 bit 9 (see 7.18.7.40) to zero or IDENTIFY PACKET DEVICE data word 83 bit 9 (see 7.19.6.34) to zero; and

c)   clear IDENTIFY DEVICE data word 94 (see 7.18.7.48) to zero or IDENTIFY PACKET DEVICE data word 94 (see 7.19.6.42) to zero.

Bit 5 of word 7 is obsolete.

If bit 4 of word 7 is cleared to zero, and the PUIS feature set has not been enabled by a jumper, then the device shall:

  a) disable support for the Power-Up In Standby feature set;
  b) clear IDENTIFY DEVICE data word 83 bits (6:5) (see 7.18.7.40) to zero or IDENTIFY PACKET DEVICE data word 83 bits (6:5) (see 7.19.6.34) to zero; and
  c) clear IDENTIFY DEVICE data word 86 bits (6:5) (see 7.18.7.41) to zero or IDENTIFY PACKET DEVICE data word 86 bits (6:5) (see 7.19.6.35) to zero.

If bit 4 of word 7 is cleared to zero, and PUIS has been enabled by jumper, then the DEVICE CONFIGURATION SET command shall return command aborted and the IDENTIFY DEVICE data and IDENTIFY PACKET DEVICE data words shall remain unchanged.

If bit 3 of word 7 is cleared to zero, and security is disabled, then the device shall:

  a) save any Master Password and Master Password Identifier;
  b) disable support for the Security feature set;
  c) not change its Security state;
  d) clear
      A) IDENTIFY DEVICE data
          a) word 82 bit 1 (see 7.18.7.40) to zero;
          b) word 85 bit 1 (see 7.18.7.41) to zero;
          c) word 90 (see 7.18.7.44) to zero;
          d) word 92 (see 7.18.7.46) to zero; and
          e) word 128 (see 7.18.7.66) to zero;

          or

      B) IDENTIFY PACKET DEVICE data
          a) word 82 bit 1 (see 7.19.6.34) to zero;
          b) word 85 bit 1 (see 7.19.6.35) to zero;
          c) word 90 (see 7.19.6.38) to zero;
          d) word 92 (see 7.19.6.40) to zero; and
          e) word 128 (see 7.19.6.51) to zero.

If bit 3 of word 7 is cleared to zero, and security is enabled, then the device shall return command aborted for the DEVICE CONFIGURATION SET command.

If bit 2 of word 7 is cleared to zero, then the device shall:

  a) disable support for SMART error logging;
  b) clear IDENTIFY DEVICE data word 84 bit 0 (see 7.18.7.40) to zero; and
  c) clear IDENTIFY DEVICE data word 87 bit 0 (see 7.18.7.41) to zero.

If bit 1 of word 7 is cleared to zero, then the device shall:

  a) disable support for the SMART Off-line self-test, Short self test, and Extended self-test;
  b) return command aborted for subsequent SMART EXECUTE OFF-LINE IMMEDIATE commands with an Execute SMART Off-line, Short, or Extended self-test routine subcommand;
  c) clear Device SMART data structure Offline Data Collection Capabilities bit 4 (see 7.55.6.10) to zero;
  d) clear Device SMART data structure Offline Data Collection Capabilities bit 3 (see 7.55.6.10) to zero;
  e) clear IDENTIFY DEVICE data word 84 bit 1 (see 7.18.7.40) to zero; and
  f) clear IDENTIFY DEVICE data word 87 bit 1 (see 7.18.7.41) to zero.

If bit 1 of word 7 is cleared to zero, bit 12 and bit 13 of word 7 are not supported, then the device may:

  a) disable support for the SMART Conveyance self-test;
  b) return command aborted for subsequent SMART EXECUTE OFF-LINE IMMEDIATE commands with an Execute SMART Conveyance self-test routine subcommand;
  c) clear Device SMART data structure Offline Data Collection Capabilities bit 5 (see 7.55.6.10) to zero;
  d) disable support for the SMART Selective self-test;
  e) return command aborted subsequent SMART EXECUTE OFF-LINE IMMEDIATE commands with an Execute SMART Selective self-test routine subcommand; and

    f)   clear Device SMART data structure Offline Data Collection Capabilities bit 5 (see 7.55.6.10) to zero.

If bit 0 of word 7 is cleared to zero, and bits (2:1) of word 7 are cleared to zero, then the device shall:

    a)   disable support for the SMART feature set;
    b)   clear IDENTIFY DEVICE data word 82 bit 0 (see 7.18.7.40) to zero; and
    c)   clear IDENTIFY DEVICE data word 85 bit 0 (see 7.18.7.41) to zero.

If bit 0 of word 7 is cleared to zero, and bits (2:1) of word 7 are not both cleared to zero, then the device shall return command aborted for the DEVICE CONFIGURATION SET command.

7.11.6.6.7 Word 8: Serial ATA Command set/feature set supported

This word enables configuration of command sets and feature sets.

Bits (15:5) of word 8 are reserved for Serial ATA . If bit 4 of word 8 is cleared to zero, then the device shall:

    a)   disable support for the SSP feature set;
    b)   clear
        A)   IDENTIFY DEVICE data:
            a)   word 78 bit 6 (see 7.18.7.36) to zero; and
            b)   word 79 bit 6 (see 7.18.7.37) to zero;

            or

        B)   IDENTIFY PACKET DEVICE data:
            a)   word 78 bit 6 (see 7.19.6.30) to zero; and
            b)   word 79 bit 6 (see 7.19.6.31) to zero;
    c)   clear any software settings that would be cleared when the SSP feature set is disabled.

If bit 3 of word 8 is cleared to zero, then the device shall:

    a)   disable support for asynchronous notification (see the Serial ATA specification);
    b)   clear
        A)   IDENTIFY DEVICE data:
            a)   word 78 bit 5 (see 7.18.7.36) to zero; and
            b)   word 79 bit 5 (see 7.18.7.37) to zero;

            or

        B)   IDENTIFY PACKET DEVICE data:
            a)   word 78 bit 5 to (see 7.19.6.30) zero; and
            b)   word 79 bit 5 (see 7.19.6.31) to zero.

If bit 2 of word 8 is cleared to zero, then the device shall:

    a)   disable support for interface power management requests (see the Serial ATA specification);
    b)   clear
        A)   IDENTIFY DEVICE data:
            a)   word 76 bit 9 (see 7.18.7.34) to zero;
            b)   word 78 bit 3 (see 7.18.7.36) to zero; and
            c)   word 79 bit 3 (see 7.18.7.37) to zero;

            or

        B)   IDENTIFY PACKET DEVICE data:
            a)   word 76 bit 9 (see 7.19.6.28) to zero;
            b)   word 78 bit 3 (see 7.19.6.30) to zero; and
            c)   word 79 bit 3 (see 7.19.6.31) to zero.

If bit 1 of word 8 is cleared to zero, then the device shall:

    a)   disable support for non-zero buffer offsets for NCQ commands (also see the Serial ATA specification);
    b)   clear
        A)   IDENTIFY DEVICE data:
            a)   word 78 bit 1 (see 7.18.7.36) to zero;

   b) word 78 bit 4 (see 7.18.7.36) to zero;
   c) word 79 bit 1 (see 7.18.7.37) to zero; and
   d) word 79 bit 4 (see 7.18.7.37) to zero;

   or

B) IDENTIFY PACKET DEVICE data:
   a) word 78 bit 1 (see 7.19.6.30) to zero;
   b) word 78 bit 4 (see 7.19.6.30) to zero;
   c) word 79 bit 1 (see 7.19.6.31) to zero; and
   d) word 79 bit 4 (see 7.19.6.31) to zero.

If bit 0 of word 8 is cleared to zero, then the device shall:

a) disable support for the NCQ feature set;
b) clear
   A) IDENTIFY DEVICE data:
      a) word 76 bit 8 (see 7.18.7.34) to zero;
      b) word 78 bit 1 (see 7.18.7.36) to zero;
      c) word 78 bit 2 (see 7.18.7.36) to zero;
      d) word 78 bit 4 (see 7.18.7.36) to zero;
      e) word 79 bit 1 (see 7.18.7.37) to zero;
      f) word 79 bit 2 (see 7.18.7.37) to zero; and
      g) word 79 bit 4 (see 7.18.7.37) to zero;

      or

   B) IDENTIFY PACKET DEVICE data:
      a) word 76 bit 8 (see 7.19.6.28) to zero;
      b) word 78 bit 1 (see 7.19.6.30) to zero;
      c) word 78 bit 2 (see 7.19.6.30) to zero;
      d) word 78 bit 4 (see 7.19.6.30) to zero;
      e) word 79 bit 1 (see 7.19.6.31) to zero;
      f) word 79 bit 2 (see 7.19.6.31) to zero; and
      g) word 79 bit 4 (see 7.19.6.31) to zero;

7.11.6.6.8 Word 9: Reserved for Serial ATA

Word 9 is reserved for use by Serial ATA.

7.11.6.6.9 Words 10..20: Reserved

7.11.6.6.10 Word 21: Command/features set supported part 2

If bit 15 of word 21 is set to one, then the device may support the NV Cache feature set . If bit 15 of word 21 is cleared to zero, and bit 14 of word 21 is set to one, then the device shall return command aborted for the DEVICE CONFIGURATION SET command . If bit 15 of word 21 is cleared to zero, and there is pinned data or the NV Cache has not been flushed, then the device shall return command aborted for the DEVICE CONFIGURATION SET command.

If bit 15 and bit 14 of word 21 is set to one, then the device may support the NV Cache Power Management feature set.

If bit 13 of word 21 is set to one, then the device may support the WRITE UNCORRECTABLE EXT command.

If bit 12 of word 21 is cleared to zero and security is disabled, then the device shall:

a) disable support for the Trusted Computing feature set; and
b) clear bit 0 of word 48 in IDENTIFY DEVICE or IDENTIFY PACKET DEVICE data to zero.

If bit 12 of word 21 is cleared to zero, and security is enabled, then the device shall return command aborted for the DEVICE CONFIGURATION SET command.

If bit 11 of word 21 is set to one, then the device may support the Free-fall Control feature set.

If bit 10 of word 21 is set to one, then the device may support the DATA SET MANAGEMENT command.

If bit 9 of word 21 is cleared to zero, then the device shall:

    a)   disable support for the Extended Power Conditions feature;
    b)   change the Log Directory to indicate that the Power Conditions log is not supported;
    c)   clear IDENTIFY DEVICE data word 119 bit 7 (see 7.18.7.40) to zero; and
    d)   clear IDENTIFY DEVICE data word 120 bit 7 (see 7.18.7.41) to zero.

Bits (8:0) of word 21 are reserved.

7.11.6.6.11 Word 22: Command/features set supported part 3

Bit (15:0) of word 22 are reserved.

7.11.6.6.12 Words 23..207: Reserved

7.11.6.6.13 Words 208..254: Vendor Specific

7.11.6.6.14 Word 255: Integrity word

Bits (7:0) of word 255 shall contain the value A5h . Bits (15:8) of word 255 shall contain the data structure checksum . The data structure checksum shall be the two's complement of the sum of all bytes in words 0..254 and the byte consisting of bits (7:0) of word 255 . Each byte shall be added with unsigned arithmetic and overflow shall be ignored . The sum of all bytes is zero when the checksum is correct.

7.11.7 DEVICE CONFIGURATION SET DMA - B1h/C5h, DMA

7.11.7.1 Feature Set

This 28-bit command is for devices implementing the DCO feature set (see 4.8).

7.11.7.2 Description

See 7.11.6.2.

7.11.7.3 Inputs

See table 44 for the DEVICE CONFIGURATION SET DMA command inputs.

Table 44 — DEVICE CONFIGURATION SET DMA command inputs

Name	Description
Feature	C5h
Count	N/A
LBA	N/A
Device	**Bit Description** 7:5 N/A 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B1h

7.11.7.4 Normal Outputs

See 7.11.6.4.

7.11.7.5 Error Outputs

See 7.11.6.5.

7.11.7.6 Output From the Host to the Device Data Structure

See 7.11.6.6.

7.12 DEVICE RESET - 08h, Device Reset

7.12.1 Feature Set

This 28-bit command is for ATAPI devices (see 4.3).

7.12.2 Description

The DEVICE RESET command resets the device.

7.12.3 Inputs

See table 45 for the DEVICE RESET command inputs.

Table 45 — DEVICE RESET command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 08h

7.12.4 Normal Outputs

See table 221.

7.12.5 Error Outputs

ATAPI devices shall not report an error . If the device is able to complete the DEVICE RESET and maintain the device setting, then DEVICE RESET shall complete with Check Condition cleared to zero . If the device reverts to its default state, then the device shall report an exception by setting the Check Condition bit to one in the Status field.

7.13 DOWNLOAD MICROCODE - 92h, PIO Data-Out/Non-Data

7.13.1 Feature Set

This 28-bit command is for ATA devices (see 4.2).

7.13.2 Description

The DOWNLOAD MICROCODE command enables the host to alter the device's microcode . The data transferred using the DOWNLOAD MICROCODE command is vendor specific.

All transfers shall be zero length or an integer multiple of 512-byte data blocks . The size of the data transfer is determined by the content of the LBA field and Count field, allowing transfer sizes from 0 bytes to 33 553 920 bytes . If a value of zero is in both fields, then the Non-Data transfer protocol shall be used.

The Feature field indicates the mode of the DOWNLOAD MICROCODE command as described in 7.13.3.

The optional Download with offsets and save microcode for immediate and future use (see 7.18.7.40) allows the application client to transfer microcode in two or more DOWNLOAD MICROCODE commands.

The download block count value in the Count field and LBA field shall specify how many 512-byte blocks of data are being transferred in one command.

The buffer offset is defined by the value in the LBA (23:8) . The buffer offset is the starting location in the data relative to the last successful DOWNLOAD MICROCODE command received by the device with a buffer offset of zero . The buffer offset shall be between 0 and 65 535 . The buffer offset value is the byte count divided by 512 (e.g., if a microcode file is to be transferred to the device in 32 768 byte segments the first command should be issued with buffer offset value of zero, the second command should be issued with a buffer offset of 64, the third command should be issued with a buffer offset value of 128 and so on until the complete microcode is transferred).

If the current buffer offset is not equal to the sum of the previous DOWNLOAD MICROCODE command buffer offset and the previous block count, then the device shall report command aborted for the DOWNLOAD MICROCODE command and discard all previously downloaded microcode . The first DOWNLOAD MICROCODE command shall have a buffer offset of zero .

When the device detects the last DOWNLOAD MICROCODE command for the microcode download the device shall perform any device required verification and save the complete set of downloaded microcode . Device feature configuration (e.g., SET FEATURES settings) may be affected by the download microcode command.

The new microcode should become effective before the device reports command completion for the last data segment.

If the device receives a command other than DOWNLOAD MICROCODE command prior to the receipt of the last segment, then the device shall process the new command and may discard previously downloaded microcode.

During the processing of a power-on reset, a hardware reset, or a software reset prior to applying the new microcode, the device shall discard any received microcode segments.

7.13.3 Inputs

See table 46 for the DOWNLOAD MICROCODE command inputs.

Table 46 — DOWNLOAD MICROCODE command inputs

Name	Description
Feature	**Sub** **command Description** 00h Reserved 01h Obsolete 02h Reserved 03h Download with offsets and save microcode for immediate and future use. 04h-06h Reserved 07h Download and save microcode for immediate and future use. 08-FFh Reserved
Count	Block count (7:0)
LBA	**Bit Description** 27:24 Reserved 23:8 Buffer offset (only used for Feature = 03h, otherwise this field shall be reserved) 7:0 Block count (15:8)
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 92h

7.13.4 Normal Outputs

If IDENTIFY DEVICE data word 234 (see 7.18.7.90) or IDENTIFY DEVICE data word 235 (see 7.18.7.91) have a value other than 0000h or FFFFh, then table 47 describes the indicator returned in the Count field.

Table 47 — Count field output for DOWNLOAD MICROCODE requesting the offset transfer method

Value	Description
00h	No indication of download microcode status.
01h	Indicates the ATA device is expecting more download microcode commands to follow.
02h	Indicates that the ATA device has applied the new microcode.
03h-FFh	Reserved

For additional returns see table 215.

7.13.5 Error Outputs

The device shall return command aborted if the device did not accept the microcode data . The device shall return command aborted if the subcommand code is not a supported value . See table 240.

7.14 DOWNLOAD MICROCODE DMA - 93h, DMA

7.14.1 Feature Set

This 28-bit command is for ATA devices (see 4.2).

7.14.2 Description

See 7.13.2.

7.14.3 Inputs

See table 48 for the DOWNLOAD MICROCODE command inputs.

Table 48 — DOWNLOAD MICROCODE command inputs

Name	Description
Feature	See the Feature field in 7.13.3.
Count	See the Count field in 7.13.3.
LBA	See the LBA field in 7.13.3.
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 93h

7.14.4 Normal Outputs

See 7.13.4.

7.14.5 Error Outputs

See 7.13.5.

7.15 EXECUTE DEVICE DIAGNOSTIC - 90h, Execute Device Diagnostic

7.15.1 Feature Set

This 28-bit command is for all devices (see 4.2 and 4.3).

7.15.2 Description

The EXECUTE DEVICE DIAGNOSTIC command shall cause the device to perform internal diagnostic tests.

> NOTE 9 — There are transport and Host Adapter implications for this command (i.e., see ATA8-APT and HBA2).

If the host issues an EXECUTE DEVICE DIAGNOSTIC command while a device is in, or transitioning to, a power management state other than the PM3:Sleep state (see figure 14), then the device shall process the diagnostic sequence.

7.15.3 Inputs

See table 49 for the EXECUTE DEVICE DIAGNOSTIC command inputs.

Table 49 — EXECUTE DEVICE DIAGNOSTIC command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 90h

7.15.4 Normal Outputs

See table 221 . The diagnostic code written into the Error field is an 8-bit code . Table 50 defines these values.

Table 50 — Diagnostic codes

Code [a]	Description
When this code is in the Device 0 [c] Error field	
01h	Device 0 [c] passed, Device 1 [c] passed or not present
00h, 02h-7Fh	Device 0 [c] failed, Device 1 [c] passed or not present
81h	Device 0 [c] passed, Device 1 [c] failed
80h, 82h-FFh	Device 0 [c] failed, Device 1 [c] failed
When this code is in the Device 1 [c] Error field	
01h	Device 1 [c] passed [b]
00h, 02h-7Fh	Device 1 [c] failed [b]
80h-FFh	Reserved
[a] Codes other than 01h and 81h may indicate additional information about the failure(s). [b] If Device 1 is not present, the host may see the information from Device 0 even though Device 1 is selected. [c] See the appropriate transport standard for the definition of device 0 and device 1.	

7.15.5 Error Outputs

This command shall complete without setting the Error bit to one (see 7.15.4).

7.16 FLUSH CACHE - E7h, Non-Data

7.16.1 Feature Set

This 28-bit command is for ATA devices (see 4.2) and ATAPI devices (see 4.3).

7.16.2 Description

The FLUSH CACHE command requests the device to flush the volatile write cache . If there is data in the volatile write cache, that data shall be written to the non-volatile media . This command shall not indicate completion until the data is flushed to the non-volatile media or an error occurs . If the device supports more than 28 bits of addressing this command shall attempt to flush all the data in the volatile cache . If the volatile write cache is disabled or no volatile write cache is present, the device shall indicate command completion without error.

> NOTE 10 — This command may take longer than 30 seconds to complete.

7.16.3 Inputs

See table 51 for the FLUSH CACHE command inputs.

Table 51 — FLUSH CACHE command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 E7h

7.16.4 Normal Outputs

See table 215.

7.16.5 Error Outputs

If an unrecoverable error occurs while the device is writing data to its media, then the device shall terminate processing the command and report the error, including the LBA of the first sector where an unrecoverable error occurred . Subsequent FLUSH CACHE commands continue the process of flushing the cache . See table 245.

If an error occurs during the flush process and the LBA of the data in error is outside the 28-bit address range, then the LBA of the logical sector in error is incorrectly reported . For correct error reporting in a device that has more than a 28-bit address range, use the FLUSH CACHE EXT command (see 7.17).

7.17 FLUSH CACHE EXT - EAh, Non-Data

7.17.1 Feature Set

This 48-bit command is mandatory for devices implementing the 48-bit Address feature set (see 4.4).

7.17.2 Description

The FLUSH CACHE EXT command requests the device to flush the volatile write cache . If there is data in the volatile write cache, that data shall be written to the non-volatile media . This command shall not indicate completion until the data is flushed to the non-volatile media or an error occurs . If the volatile write cache is disabled or no volatile write cache is present, the device shall indicate command completion without error.

> NOTE 11 — This command may take longer than 30 seconds to complete.

7.17.3 Inputs

See table 51 for the FLUSH CACHE EXT command inputs.

Table 52 — FLUSH CACHE EXT command inputs

Name	Description
Feature	Reserved
Count	Reserved
LBA	Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 EAh

7.17.4 Normal Outputs

See table 227.

7.17.5 Error Outputs

If an unrecoverable error occurs while the device is writing data to its media, then the device shall terminate processing the command and report the error, including the LBA of the first sector where an unrecoverable error occurred . If a device receives a subsequent FLUSH CACHE EXT command, then the device shall continue the process of flushing its cache . See table 246.

7.18 IDENTIFY DEVICE - ECh, PIO Data-In

7.18.1 Feature Set

This 28-bit command is mandatory for all devices (see 4.2 and 4.3).

7.18.2 Description

The IDENTIFY DEVICE command specifies that the device shall send a 512-byte block of data to the host . See 7.18.7 for a description of the return data.

Devices may read the non-volatile media in order to complete this command.

The IDENTIFY DEVICE data contains information regarding optional feature or command support . If the host issues a command that is indicated as not supported in the IDENTIFY DEVICE data, the device shall return command aborted for the command.

7.18.3 Inputs

See table 53 for the IDENTIFY DEVICE command inputs.

Table 53 — IDENTIFY DEVICE command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 ECh

7.18.4 Normal Outputs for ATA devices

See table 215.

7.18.5 Normal Outputs for ATAPI devices

In response to this command, ATAPI devices shall return command aborted and place the PACKET feature set signature in the appropriate fields (see table 221)**.**

7.18.6 Error Outputs

ATA devices shall not report an error, except after a NCQ Feature Set command error and before the NCQ Command Error Log is read (see table 240).

7.18.7 Input From the Device to the Host Data Structure

7.18.7.1 Overview

Table 54 specifies the format of the IDENTIFY DEVICE data.

Table 54 — IDENTIFY DEVICE data (part 1 of 20)

Word	O M	S P	F V	Description
0	M	B		General configuration (see 7.18.7.2)
			F	15 0 = ATA device
			X	14:8 Retired
			X	7:6 Obsolete
			X	5:3 Retired
			V	2 Response incomplete
			X	1 Retired
				0 Reserved
1			X	Obsolete
2	O	B	V	Specific configuration (see 7.18.7.4)
3			X	Obsolete
4..5			X	Retired
6			X	Obsolete
7..8		N		Reserved for the CompactFlash Association
9			X	Retired
10..19	M	B	F	Serial number (ATA string) (see 7.18.7.10)
20..21			X	Retired
22			X	Obsolete
23..26	M	B	F	Firmware revision (ATA string) (see 7.18.7.13)
27..46	M	B	F	Model number (ATA string) (see 7.18.7.14)
47	M			See 7.18.7.15
		B	F	15:8 80h
		B	F	7:0 00h = Reserved
				01h-FFh = Maximum number of logical sectors that shall be transferred per DRQ data block on READ/WRITE MULTIPLE commands
Key: F/V – Fixed/variable content F – The content of the field is fixed and does not change . The DCO command may change the value of a fixed field. V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device. X – The fixed or variable type of this field is not defined in this standard.				O/M – Mandatory/optional requirement. M – Support of the word is mandatory. O – Support of the word is optional. S/P – Content applies to Serial or Parallel transport S – Serial Transport P – Parallel Transport B – Both Serial and Parallel Transports N – Belongs to a transport other than Serial or Parallel

Table 54 — IDENTIFY DEVICE data (part 2 of 20)

Word	O M	S P	F V	Description
48	O	B		Trusted Computing feature set options (see 7.18.7.16)
			F	15 Shall be cleared to zero
			F	14 Shall be set to one
				13:1 Reserved for the Trusted Computing Group
			F	0 1=Trusted Computing feature set is supported
49	M			Capabilities (see 7.18.7.17)
				15:14 Reserved for the IDENTIFY PACKET DEVICE command.
		B	F	13 1 = Standby timer values as specified in this standard are supported
				0 = Standby timer values shall be managed by the device
				12 Reserved for the IDENTIFY PACKET DEVICE command.
		P	F	11 1 = IORDY (see ATA8-APT) supported
				0 = IORDY (see ATA8-APT) may be supported
		P	F	10 1 = IORDY (see ATA8-APT) may be disabled
		B	F	9 Shall be set to one to indicate that LBA is supported.
		P	F	8 1 = DMA supported
		X		7:2 Reserved
				1:0 Current Long Physical Sector Alignment setting
50	M			Capabilities (see 7.18.7.17)
		B	F	15 Shall be cleared to zero
		B	F	14 Shall be set to one
				13:2 Reserved
		X		1 Obsolete
		B	F	0 Shall be set to one to indicate a vendor specific Standby timer value minimum
51..52			X	Obsolete

Key:
F/V – Fixed/variable content
    F – The content of the field is fixed and does not change . The DCO command may change the value of a fixed field.
    V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
    X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
    M – Support of the word is mandatory.
    O – Support of the word is optional.
S/P – Content applies to Serial or Parallel transport
    S – Serial Transport
    P – Parallel Transport
    B – Both Serial and Parallel Transports
    N – Belongs to a transport other than Serial or Parallel

Table 54 — IDENTIFY DEVICE data (part 3 of 20)

Word	O M	S P	F V	Description
53				See 7.18.7.19
	M	B	F	15:8 Free-fall Control Sensitivity
				00h = Vendor's recommended setting
				01h-FFh = Sensitivity level . A larger number is a more sensitive setting.
				7:3 Reserved
		B	F	2 1 = the fields reported in word 88 are valid
				0 = the fields reported in word 88 are not valid
		B	F	1 1 = the fields reported in words (70:64) are valid
				0 = the fields reported in words (70:64) are not valid
			X	0 Obsolete
54..58			X	Obsolete
59				See 7.18.7.21
	M			15 1 = The BLOCK ERASE EXT command is supported (see 7.43.2)
				14 1= The OVERWRITE EXT command is supported (see 7.43.4)
				13 1 = The CRYPTO SCRAMBLE EXT command is supported (see 7.43.3)
				12 1 = The Sanitize feature set is supported (see 4.21)
				11:9 Reserved
		B	V	8 1 = Multiple logical sector setting is valid
		B	V	7:0 Current setting for number of logical sectors that shall be transferred per DRQ data block on READ/WRITE Multiple commands
60..61	M	B	F	Total number of user addressable logical sectors for 28-bit commands (DWord) (see 7.18.7.22)
62			X	Obsolete

Key:
F/V – Fixed/variable content
     F – The content of the field is fixed and does not change . The DCO command may change the value of a fixed field.
     V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
     X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
     M – Support of the word is mandatory.
     O – Support of the word is optional.
S/P – Content applies to Serial or Parallel transport
     S – Serial Transport
     P – Parallel Transport
     B – Both Serial and Parallel Transports
     N – Belongs to a transport other than Serial or Parallel

Table 54 — IDENTIFY DEVICE data (part 4 of 20)

Word	O M	S P	F V	Description
63				See 7.18.7.24
	M			15:11 Reserved
		P	V	10 1 = Multiword DMA mode 2 is selected
				0 = Multiword DMA mode 2 is not selected
		P	V	9 1 = Multiword DMA mode 1 is selected
				0 = Multiword DMA mode 1 is not selected
		P	V	8 1 = Multiword DMA mode 0 is selected
				0 = Multiword DMA mode 0 is not selected
				7:3 Reserved
		P	F	2 1 = Multiword DMA mode 2 and below are supported
		P	F	1 1 = Multiword DMA mode 1 and below are supported
		P	F	0 1 = Multiword DMA mode 0 is supported
64				See 7.18.7.25
	M			15:8 Reserved
		P	F	7:0 PIO modes supported
65	M			Minimum Multiword DMA transfer cycle time per word (see 7.18.7.26)
		P	F	15:0 Cycle time in nanoseconds
66	M			Manufacturer's recommended Multiword DMA transfer cycle time (see 7.18.7.27)
		P	F	15:0 Cycle time in nanoseconds
67	M			Minimum PIO transfer cycle time without flow control (see 7.18.7.28)
		P	F	15:0 Cycle time in nanoseconds
68	M			Minimum PIO transfer cycle time with IORDY (see ATA8-APT) flow control (see 7.18.7.29)
		P	F	15:0 Cycle time in nanoseconds

Key:	O/M – Mandatory/optional requirement.
F/V – Fixed/variable content	M – Support of the word is mandatory.
F – The content of the field is fixed and does not change . The DCO command may change the value of a fixed field.	O – Support of the word is optional.
	S/P – Content applies to Serial or Parallel transport
	S – Serial Transport
V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.	P – Parallel Transport
	B – Both Serial and Parallel Transports
	N – Belongs to a transport other than Serial or Parallel
X – The fixed or variable type of this field is not defined in this standard.	

Table 54 — IDENTIFY DEVICE data (part 5 of 20)

Word	O M	S P	F V	Description
69				Additional Supported (see 7.18.7.30)
	O	S	F	15 1 = CFast Specification Support
	O	B	F	14 1 = Deterministic data in trimmed LBA range(s) is supported
	O	B	F	13 1 = Long Physical Sector Alignment Error Reporting Control is supported
	O	B	F	12 1 = DEVICE CONFIGURATION IDENTIFY DMA and DEVICE CONFIGURATION SET DMA are supported
	O	B	F	11 1 = READ BUFFER DMA is supported
	O	B	F	10 1 = WRITE BUFFER DMA is supported
	O	B	F	9 1 = SET MAX SET PASSWORD DMA and SET MAX UNLOCK DMA are supported
	O	B	F	8 1 = DOWNLOAD MICROCODE DMA is supported
				7 Reserved for IEEE 1667
	M	B	F	6 0 = Optional ATA device 28-bit commands supported
				5 1 = Trimmed LBA range(s) returning zeroed data is supported
				4 1 = Extended Number of User Addressable Sectors is supported
				3:0 Reserved
70				Reserved
71..74				Reserved for the IDENTIFY PACKET DEVICE command
75	O			Queue depth (see 7.18.7.33)
				15:5 Reserved
		B	F	4:0 Maximum queue depth - 1

Key:
F/V – Fixed/variable content
    F – The content of the field is fixed and does not change . The DCO command may change the value of a fixed field.
    V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
    X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
    M – Support of the word is mandatory.
    O – Support of the word is optional.
S/P – Content applies to Serial or Parallel transport
    S – Serial Transport
    P – Parallel Transport
    B – Both Serial and Parallel Transports
    N – Belongs to a transport other than Serial or Parallel

Table 54 — IDENTIFY DEVICE data (part 6 of 20)

Word	O M	S P	F V	Description
76	O	S		Serial ATA Capabilities (see 7.18.7.34)
				15:13 Reserved for Serial ATA
				12 1 = Supports NCQ priority information
				11 1 = Supports Unload while NCQ commands are outstanding
			F	10 1 = Supports the SATA Phy Event Counters log
			F	9 1 = Supports receipt of host initiated power management requests
			F	8 1 = Supports the NCQ feature set
				7:3 Reserved for Serial ATA
			F	2 1 = Supports SATA Gen2 Signaling Speed (3.0Gb/s)
			F	1 1 = Supports SATA Gen1 Signaling Speed (1.5Gb/s)
			F	0 Shall be cleared to zero
77		S		Reserved for Serial ATA
78	O	S		Serial ATA features supported (see 7.18.7.36)
				15:7 Reserved for Serial ATA
			F	6 1 = Device supports Software Settings Preservation
				5 Reserved for Serial ATA
			F	4 1 = Device supports in-order data delivery
			F	3 1 = Device supports initiating power management
			F	2 1 = Device supports DMA Setup auto-activation
			F	1 1 = Device supports non-zero buffer offsets
			F	0 Shall be cleared to zero
79	O	S		Serial ATA features enabled (see 7.18.7.37)
				15:7 Reserved for Serial ATA
			V	6 1 = Software Settings Preservation enabled
				5 Reserved for Serial ATA
			V	4 1 = In-order data delivery enabled
			V	3 1 = Device initiated power management enabled
			V	2 1 = DMA Setup auto-activation enabled
			V	1 1 = Non-zero buffer offsets enabled
			F	0 Shall be cleared to zero

Key:
F/V – Fixed/variable content
    F – The content of the field is fixed and does not change . The DCO command may change the value of a fixed field.
    V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
    X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
    M – Support of the word is mandatory.
    O – Support of the word is optional.
S/P – Content applies to Serial or Parallel transport
    S – Serial Transport
    P – Parallel Transport
    B – Both Serial and Parallel Transports
    N – Belongs to a transport other than Serial or Parallel

Table 54 — IDENTIFY DEVICE data (part 7 of 20)

Word	O M	S P	F V	Description
80	M			Major version number (see 7.18.7.38)
				15:10 Reserved
				9 1 = supports ACS-2
		B	F	8 1 = supports ATA8-ACS
		B	F	7 1 = supports ATA/ATAPI-7
		B	F	6 1 = supports ATA/ATAPI-6
		B	F	5 1 = supports ATA/ATAPI-5
		B	F	4 Obsolete
			X	3 Obsolete
			X	2 Obsolete
			X	1 Obsolete
				0 Reserved
81	M	B	F	Minor version number (see 7.18.7.39)

Key:
F/V – Fixed/variable content
    F – The content of the field is fixed and does not change . The DCO command may change the value of a fixed field.
    V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
    X – The fixed or variable type of this field is not defined in this standard.
	O/M – Mandatory/optional requirement.
	    M – Support of the word is mandatory.
	    O – Support of the word is optional.
	S/P – Content applies to Serial or Parallel transport
	    S – Serial Transport
	    P – Parallel Transport
	    B – Both Serial and Parallel Transports
	    N – Belongs to a transport other than Serial or Parallel

Table 54 — IDENTIFY DEVICE data (part 8 of 20)

Word	O M	S P	F V	Description
82	M			Commands and feature sets supported (see 7.18.7.40)
			X	15 Obsolete
		B	F	14 1 = The NOP command is supported
		B	F	13 1 = The READ BUFFER command is supported
		B	F	12 1 = The WRITE BUFFER command is supported
			X	11 Obsolete
		B	F	10 1 = The HPA feature set is supported
		B	F	9 Shall be cleared to zero to indicate that the DEVICE RESET command is not supported
		B	F	8 1 = The SERVICE interrupt is supported
		B	F	7 1 = The release interrupt is supported
		B	F	6 1 = Read look-ahead is supported
		B	F	5 1 = The volatile write cache is supported
		B	F	4 Shall be cleared to zero to indicate that the PACKET feature set is not supported
		B	F	3 Shall be set to one to indicate that the mandatory Power Management feature set is supported
			X	2 Obsolete
		B	F	1 1 = The Security feature set is supported
		B	F	0 1 = The SMART feature set is supported

Key:	O/M – Mandatory/optional requirement.
F/V – Fixed/variable content	M – Support of the word is mandatory.
F – The content of the field is fixed and does not change . The DCO command may change the value of a fixed field.	O – Support of the word is optional.
	S/P – Content applies to Serial or Parallel transport
V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.	S – Serial Transport P – Parallel Transport B – Both Serial and Parallel Transports
X – The fixed or variable type of this field is not defined in this standard.	N – Belongs to a transport other than Serial or Parallel

Table 54 — IDENTIFY DEVICE data (part 9 of 20)

Word	O M	S P	F V	Description
83	M			Commands and feature sets supported (see 7.18.7.40)
			F	15 Shall be cleared to zero
			F	14 Shall be set to one
		B	F	13 1 = The FLUSH CACHE EXT command is supported
		B	F	12 Shall be set to one to indicate that the mandatory FLUSH CACHE command is supported
		B	F	11 1 = The DCO feature set is supported
		B	F	10 1 = The 48-bit Address feature set is supported
		B	F	9 1 = The AAM feature set is supported
		B	F	8 1 = The SET MAX security extension is supported
				7 Reserved for the Address Offset Reserved Area Boot Method
		B	F	6 1 = SET FEATURES subcommand is required to spin-up after power-up
		B	F	5 1 = The PUIS feature set is supported
			X	4 Obsolete
		B	F	3 1 = The APM feature set is supported
		N	F	2 1 = The CFA feature set is supported
			X	1 Obsolete
		B	F	0 1 = The DOWNLOAD MICROCODE command is supported

Key:	
F/V – Fixed/variable content F – The content of the field is fixed and does not change . The DCO command may change the value of a fixed field. V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device. X – The fixed or variable type of this field is not defined in this standard.	O/M – Mandatory/optional requirement. M – Support of the word is mandatory. O – Support of the word is optional. S/P – Content applies to Serial or Parallel transport S – Serial Transport P – Parallel Transport B – Both Serial and Parallel Transports N – Belongs to a transport other than Serial or Parallel

Table 54 — IDENTIFY DEVICE data (part 10 of 20)

Word	O M	S P	F V	Description
84	M			Commands and feature sets supported (see 7.18.7.40)
			F	15 Shall be cleared to zero
			F	14 Shall be set to one
		B	F	13 1 = The IDLE IMMEDIATE command with UNLOAD feature is supported
				12 Reserved for TLC
				11 Reserved for TLC
		X		10:9 Obsolete
		B	F	8 1 = The 64-bit World wide name is supported
		X		7 Obsolete
		B	F	6 1 = The WRITE DMA FUA EXT and WRITE MULTIPLE FUA EXT commands are supported
		B	F	5 1 = The GPL feature set is supported
		B	F	4 1 = The Streaming feature set is supported
		N	F	3 1 = The Media Card Pass Through Command feature set is supported
		B	F	2 1 = Media serial number is supported
		B	F	1 1 = The SMART self-test is supported
		B	F	0 1 = SMART error logging is supported

Key:
F/V – Fixed/variable content
    F – The content of the field is fixed and does not change . The DCO command may change the value of a fixed field.
    V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
    X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
    M – Support of the word is mandatory.
    O – Support of the word is optional.
S/P – Content applies to Serial or Parallel transport
    S – Serial Transport
    P – Parallel Transport
    B – Both Serial and Parallel Transports
    N – Belongs to a transport other than Serial or Parallel

Table 54 — IDENTIFY DEVICE data (part 11 of 20)

Word	O M	S P	F V	Description
85	M			Commands and feature sets supported or enabled (see 7.18.7.41)
			X	15 Obsolete
		B	F	14 1 = The NOP command is supported
		B	F	13 1 = The READ BUFFER command is supported
		B	F	12 1 = The WRITE BUFFER command is supported
			X	11 Obsolete
		B	V	10 1 = HPA feature set is supported
		B	F	9 Shall be cleared to zero to indicate that the DEVICE RESET command is not supported
		B	V	8 1 = The SERVICE interrupt is enabled
		B	V	7 1 = The release interrupt is enabled
		B	V	6 1 = Read look-ahead is enabled
		B	V	5 1 = The volatile write cache is enabled
		B	F	4 Shall be cleared to zero to indicate that the PACKET feature set is not supported
		B	F	3 Shall be set to one to indicate that the mandatory Power Management feature set is supported
			X	2 Obsolete
		B	V	1 1 = The Security feature set is enabled
		B	V	0 1 = The SMART feature set is enabled

Key:
F/V – Fixed/variable content
    F – The content of the field is fixed and does not change . The DCO command may change the value of a fixed field.
    V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
    X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
    M – Support of the word is mandatory.
    O – Support of the word is optional.
S/P – Content applies to Serial or Parallel transport
    S – Serial Transport
    P – Parallel Transport
    B – Both Serial and Parallel Transports
    N – Belongs to a transport other than Serial or Parallel

Table 54 — IDENTIFY DEVICE data (part 12 of 20)

Word	O M	S P	F V	Description
86	M			Commands and feature sets supported or enabled(see 7.18.7.41)
		B	F	15 1 = Words 119..120 are valid
				14 Reserved
		B	F	13 1 = FLUSH CACHE EXT command supported
		B	F	12 1 = FLUSH CACHE command supported
		B	F	11 1 = The DCO feature set is supported
		B	F	10 1 = The 48-bit Address features set is supported
		B	V	9 1 = The AAM feature set is enabled
		B	V	8 1 = the SET MAX security extension is enabled by SET MAX SET PASSWORD
				7 Reserved for Address Offset Reserved Area Boot Method
		B	F	6 1 = SET FEATURES subcommand is required to spin-up after power-up
		B	V	5 1 = The PUIS feature set is enabled
			X	4 Obsolete
		B	V	3 1 = The APM feature set is enabled
		N	F	2 1 = The CFA feature set is supported
			X	1 Obsolete
		B	F	0 1 = The DOWNLOAD MICROCODE command is supported

Key:	

F/V – Fixed/variable content
    F – The content of the field is fixed and does not change . The DCO command may change the value of a fixed field.
    V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
    X – The fixed or variable type of this field is not defined in this standard.
	O/M – Mandatory/optional requirement.
	    M – Support of the word is mandatory.
	    O – Support of the word is optional.
	S/P – Content applies to Serial or Parallel transport
	    S – Serial Transport
	    P – Parallel Transport
	    B – Both Serial and Parallel Transports
	    N – Belongs to a transport other than Serial or Parallel

Table 54 — IDENTIFY DEVICE data (part 13 of 20)

Word	O M	S P	F V	Description
87	M			Commands and feature sets supported or enabled(see 7.18.7.41)
			F	15 Shall be cleared to zero
			F	14 Shall be set to one
		B	F	13 1 = The IDLE IMMEDIATE command with UNLOAD FEATURE is supported
				12 Reserved for TLC
				11 Reserved for TLC
		X		10:9 Obsolete
		B	F	8 1 = The 64-bit World wide name is supported
		X		7 Obsolete
		B	F	6 1 = The WRITE DMA FUA EXT and WRITE MULTIPLE FUA EXT commands are supported
		B	F	5 1 = The GPL feature set is supported
		X		4 Obsolete
		N	V	3 1 = The Media Card Pass Through Command feature set is supported
		B	V	2 1 = Media serial number is valid
		B	F	1 1 = SMART self-test supported
		B	F	0 1 = SMART error logging is supported

Key:
F/V – Fixed/variable content
    F – The content of the field is fixed and does not change . The DCO command may change the value of a fixed field.
    V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
    X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
    M – Support of the word is mandatory.
    O – Support of the word is optional.
S/P – Content applies to Serial or Parallel transport
    S – Serial Transport
    P – Parallel Transport
    B – Both Serial and Parallel Transports
    N – Belongs to a transport other than Serial or Parallel

Table 54 — IDENTIFY DEVICE data (part 14 of 20)

Word	O M	S P	F V	Description
88	O			Ultra DMA modes (see 7.18.7.42)
				15 Reserved
		P	V	14 1 = Ultra DMA mode 6 is selected
		P		0 = Ultra DMA mode 6 is not selected
		P	V	13 1 = Ultra DMA mode 5 is selected
		P		0 = Ultra DMA mode 5 is not selected
		P	V	12 1 = Ultra DMA mode 4 is selected
		P		0 = Ultra DMA mode 4 is not selected
		P	V	11 1 = Ultra DMA mode 3 is selected
		P		0 = Ultra DMA mode 3 is not selected
		P	V	10 1 = Ultra DMA mode 2 is selected
		P		0 = Ultra DMA mode 2 is not selected
		P	V	9 1 = Ultra DMA mode 1 is selected
		P		0 = Ultra DMA mode 1 is not selected
		P	V	8 1 = Ultra DMA mode 0 is selected
		P		0 = Ultra DMA mode 0 is not selected
				7 Reserved
		P	F	6 1 = Ultra DMA mode 6 and below are supported
		P	F	5 1 = Ultra DMA mode 5 and below are supported
		P	F	4 1 = Ultra DMA mode 4 and below are supported
		P	F	3 1 = Ultra DMA mode 3 and below are supported
		P	F	2 1 = Ultra DMA mode 2 and below are supported
		P	F	1 1 = Ultra DMA mode 1 and below are supported
		P	F	0 1 = Ultra DMA mode 0 is supported
89				See 7.18.7.43
				15:8 Reserved
	O	B	F	7:0 Time required for Normal Erase mode SECURITY ERASE UNIT command
90				See 7.18.7.44
				15:8 Reserved
	O	B	F	7:0 Time required for an Enhanced Erase mode SECURITY ERASE UNIT command

Key:	O/M – Mandatory/optional requirement.
F/V – Fixed/variable content	M – Support of the word is mandatory.
F – The content of the field is fixed and does not change . The DCO command may change the value of a fixed field.	O – Support of the word is optional.
	S/P – Content applies to Serial or Parallel transport
	S – Serial Transport
V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.	P – Parallel Transport
	B – Both Serial and Parallel Transports
	N – Belongs to a transport other than Serial or Parallel
X – The fixed or variable type of this field is not defined in this standard.	

Table 54 — IDENTIFY DEVICE data (part 15 of 20)

Word	O M	S P	F V	Description
91	O	B	V	Current APM level value (see 7.18.7.45)
92	O	B	V	Master Password Identifier (see 7.18.7.46)
93	M			Hardware reset result (see 7.18.7.47)
			F	15 Shall be cleared to zero.
			F	14 Shall be set to one.
		P	V	13 1 = device detected the CBLID- above V_{iHB} (see ATA8-APT)
				0 = device detected the CBLID- below V_{iL} (see ATA8-APT)
		P		12:8 Device 1 hardware reset result . Device 0 shall clear these bits to zero . Device 1 shall set these bits as follows:
				12 Reserved.
			V	11 0 = Device 1 did not assert PDIAG-.
				1 = Device 1 asserted PDIAG-.
			V	10:9 These bits indicate how Device 1 determined the device number:
				00 = Reserved.
				01 = a jumper was used.
				10 = the CSEL signal was used.
				11 = some other method was used or the method is unknown.
				8 Shall be set to one.
		P		7:0 Device 0 hardware reset result . Device 1 shall clear these bits to zero . Device 0 shall set these bits as follows:
				7 Reserved.
			F	6 0 = Device 0 does not respond when Device 1 is selected.
				1 = Device 0 responds when Device 1 is selected.
			V	5 0 = Device 0 did not detect the assertion of DASP-.
				1 = Device 0 detected the assertion of DASP-.
			V	4 0 = Device 0 did not detect the assertion of PDIAG-.
				1 = Device 0 detected the assertion of PDIAG-.
			V	3 0 = Device 0 failed diagnostics.
				1 = Device 0 passed diagnostics.

Key:
F/V – Fixed/variable content
    F – The content of the field is fixed and does not change . The DCO command may change the value of a fixed field.
    V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
    X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
    M – Support of the word is mandatory.
    O – Support of the word is optional.
S/P – Content applies to Serial or Parallel transport
    S – Serial Transport
    P – Parallel Transport
    B – Both Serial and Parallel Transports
    N – Belongs to a transport other than Serial or Parallel

Table 54 — IDENTIFY DEVICE data (part 16 of 20)

Word	O M	S P	F V	Description
			V	2:1 These bits indicate how Device 0 determined the device number:
				00 = Reserved.
				01 = a jumper was used.
				10 = the CSEL signal was used.
				11 = some other method was used or the method is unknown.
			F	0 Shall be set to one.
94	O			Current AAM value (see 7.18.7.48)
		B	F	15:8 Vendor's recommended AAM value.
		B	V	7:0 Current AAM value.
95	O	B	F	Stream Minimum Request Size (see 7.18.7.49)
96	O	B	V	Streaming Transfer Time - DMA (see 7.18.7.50)
97	O	B	V	Streaming Access Latency - DMA and PIO (see 7.18.7.51)
98..99	O	B	F	Streaming Performance Granularity (DWord) (see 7.18.7.52)
100..103	O	B	V	Total Number of User Addressable Logical Sectors for 48-bit commands (QWord) (see 7.18.7.53)
104	O	B	V	Streaming Transfer Time - PIO (see 7.18.7.54)
105				Maximum number of 512-byte blocks per DATA SET MANAGEMENT command (see 7.10)
106	O			Physical sector size / logical sector size (see 7.18.7.56)
		B	F	15 Shall be cleared to zero
		B	F	14 Shall be set to one
		B	F	13 1 = Device has multiple logical sectors per physical sector.
		B	F	12 1 = Device Logical Sector longer than 256 Words
				11:4 Reserved
		B	F	3:0 2^X logical sectors per physical sector
107	O	B	F	Inter-seek delay for ISO 7779 standard acoustic testing (see 7.18.7.57)
108..111	M	B	F	World wide name (see 7.18.7.58)
112..115				Reserved
116				Reserved for TLC
117..118	O	B	F	Logical sector size (DWord) (see 7.18.7.61)

Key:
F/V – Fixed/variable content   O/M – Mandatory/optional requirement.

Key:
F/V – Fixed/variable content
    F – The content of the field is fixed and does not change . The DCO command may change the value of a fixed field.
    V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
    X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
    M – Support of the word is mandatory.
    O – Support of the word is optional.
S/P – Content applies to Serial or Parallel transport
    S – Serial Transport
    P – Parallel Transport
    B – Both Serial and Parallel Transports
    N – Belongs to a transport other than Serial or Parallel

Table 54 — IDENTIFY DEVICE data (part 17 of 20)

Word	O M	S P	F V	Description
119	M			Commands and feature sets supported (Continued from words 82..84) (see 7.18.7.40)
			F	15 Shall be cleared to zero
			F	14 Shall be set to one
				13:8 Reserved
				7 1 = Extended Power Conditions feature set is supported
	O	B	F	6 1 = Sense Data Reporting feature set is supported
		B	F	5 1 = The Free-fall Control feature set is supported
		B	F	4 1 = The DOWNLOAD MICROCODE command with mode 3 is supported
		B	F	3 1 = The READ LOG DMA EXT and WRITE LOG DMA EXT commands are supported
		B	F	2 1 = The WRITE UNCORRECTABLE EXT command is supported
		B	F	1 1 = The Write-Read-Verify feature set is supported
				0 Reserved for DDT
120	M			Commands and feature sets supported or enabled (Continued from words 85..87) (see 7.18.7.41)
			F	15 Shall be cleared to zero
			F	14 Shall be set to one
				13:8 Reserved
				7 1 = Extended Power Conditions feature set is enabled
	O	B	V	6 1 = Sense Data Reporting feature set is enabled
		B	V	5 1 = The Free-fall Control feature set is enabled
		B	F	4 1 = The DOWNLOAD MICROCODE command with mode 3 is supported
		B	F	3 1 = The READ LOG DMA EXT and WRITE LOG DMA EXT commands are supported
		B	F	2 1 = The WRITE UNCORRECTABLE EXT command is supported
		B	V	1 1 = The Write-Read-Verify feature set is enabled
				0 Reserved for DDT
121..126				Reserved for expanded supported and enabled settings
127			X	Obsolete

Key:	

F/V – Fixed/variable content
    F – The content of the field is fixed and does not change . The DCO command may change the value of a fixed field.
    V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
    X – The fixed or variable type of this field is not defined in this standard.
	O/M – Mandatory/optional requirement.
	    M – Support of the word is mandatory.
	    O – Support of the word is optional.
	S/P – Content applies to Serial or Parallel transport
	    S – Serial Transport
	    P – Parallel Transport
	    B – Both Serial and Parallel Transports
	    N – Belongs to a transport other than Serial or Parallel

Table 54 — IDENTIFY DEVICE data (part 18 of 20)

Word	O M	S P	F V	Description
128	O			Security status (see 7.18.7.66)
				15:9 Reserved
		B	V	8 Master Password Capability: 0 = High, 1 = Maximum
				7:6 Reserved
		B	F	5 1 = Enhanced security erase supported
		B	V	4 1 = Security count expired
		B	V	3 1 = Security frozen
		B	V	2 1 = Security locked
		B	V	1 1 = Security enabled
		B	F	0 1 = Security supported
129..159			X	Vendor specific
160	O	N		CFA power mode (see 7.18.7.68)
			F	15 Word 160 supported
				14 Reserved
			F	13 CFA power mode 1 is required for one or more commands implemented by the device
			V	12 CFA power mode 1 disabled
			F	11:0 Maximum current in ma
161..167				Reserved for the CompactFlash Association
168				See 7.18.7.70
				15:4 Reserved
	O	B	F	3:0 Device Nominal Form Factor
169				DATA SET MANAGEMENT command is supported (see 7.18.7.71)
				15:1 Reserved
	O	B	F	0 1 = the Trim bit in the DATA SET MANAGEMENT command is supported
170..173	O	B	F	Additional Product Identifier (ATA String) (see 7.18.7.72)
174..175				Reserved
176..205	O	B	V	Current media serial number (ATA string) (see 7.18.7.74)

Key:
F/V – Fixed/variable content
    F – The content of the field is fixed and does not change . The DCO command may change the value of a fixed field.
    V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
    X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
    M – Support of the word is mandatory.
    O – Support of the word is optional.
S/P – Content applies to Serial or Parallel transport
    S – Serial Transport
    P – Parallel Transport
    B – Both Serial and Parallel Transports
    N – Belongs to a transport other than Serial or Parallel

Table 54 — IDENTIFY DEVICE data (part 19 of 20)

Word	O M	S P	F V	Description
206	O	B		SCT Command Transport(see 7.18.7.75)
			X	15:12 Vendor Specific
				11:6 Reserved
			F	5 The SCT Data Tables command is supported
			F	4 The SCT Feature Control command is supported
			F	3 The SCT Error Recovery Control command is supported
			F	2 The SCT Write Same command is supported
			F	1 Obsolete
			F	0 The SCT Command Transport is supported
207..208		N		Reserved
209	O		F	Alignment of logical blocks within a physical block (see 7.18.7.76)
				15 Shall be cleared to zero
				14 Shall be set to one
			B	13:0 Logical sector offset within the first physical sector where the first logical sector is placed
210..211	O	B	V	Write-Read-Verify Sector Count Mode 3 (DWord) (see 7.18.7.77)
212..213	O	B	F	Write-Read-Verify Sector Count Mode 2 (DWord) (see 7.18.7.78)
214	O	B		NV Cache Capabilities (see 7.18.7.79)
			F	15:12 NV Cache feature set version
			F	11:8 NV Cache Power Mode feature set version
				7:5 Reserved
			V	4 1 = NV Cache feature set enabled
				3:2 Reserved
			V	1 1 = NV Cache Power Mode feature set enabled
			F	0 1 = NV Cache Power Mode feature set supported
215..216	O	B	V	NV Cache Size in Logical Blocks (DWord) (see 7.18.7.80)
217	M	B	F	Nominal media rotation rate (see 7.18.7.81)
218				Reserved
219	O	B		NV Cache Options (see 7.18.7.83)
				15:8 Reserved
			F	7:0 Device Estimated Time to Spin Up in Seconds

Key:
F/V – Fixed/variable content
    F – The content of the field is fixed and does not change . The DCO command may change the value of a fixed field.
    V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
    X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
    M – Support of the word is mandatory.
    O – Support of the word is optional.
S/P – Content applies to Serial or Parallel transport
    S – Serial Transport
    P – Parallel Transport
    B – Both Serial and Parallel Transports
    N – Belongs to a transport other than Serial or Parallel

Table 54 — IDENTIFY DEVICE data (part 20 of 20)

Word	O M	S P	F V	Description
220				See 7.18.7.84
	O	B		15:8 Reserved
			V	7:0 Write-Read-Verify feature set current mode
221				Reserved
222	M	B		Transport major version number (see 7.18.7.86) 0000h or FFFFh = device does not report version
			F	15:12 Transport Type 0h = Parallel 1h = Serial 2h-Fh = Reserved
				Parallel **Serial**
				11:6 Reserved Reserved
				5 Reserved SATA Rev 3.0
			F	4 Reserved SATA Rev 2.6
			F	3 Reserved SATA Rev 2.5
			F	2 Reserved SATA II: Extensions
			F	1 ATA/ATAPI-7 SATA 1.0a
			F	0 ATA8-APT ATA8-AST
223	M	B	F	Transport minor version number (see 7.18.7.87)
224..229		N		Reserved
230..233				Extended Number of User Addressable Sectors (QWord) (see 7.18.7.89)
234	O	B	F	Minimum number of 512-byte data blocks per DOWNLOAD MICROCODE command for mode 03h (see 7.18.7.90)
235	O	B	F	Maximum number of 512-byte data blocks per DOWNLOAD MICROCODE command for mode 03h (see 7.18.7.91)
236..254				Reserved
255	M		V	Integrity word (see 7.18.7.93)
		B		15:8 Checksum
		B		7:0 Checksum Validity Indicator

Key:
F/V – Fixed/variable content
    F – The content of the field is fixed and does not change . The DCO command may change the value of a fixed field.
    V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
    X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
    M – Support of the word is mandatory.
    O – Support of the word is optional.
S/P – Content applies to Serial or Parallel transport
    S – Serial Transport
    P – Parallel Transport
    B – Both Serial and Parallel Transports
    N – Belongs to a transport other than Serial or Parallel

7.18.7.2 Word 0: General configuration

If the device is an ATA device, then bit 15 shall be cleared to zero.

Bits (7:6) are obsolete.

If bit 2 of word 0 is set to one, then the content of the IDENTIFY DEVICE data is incomplete . This may occur if the device supports the Power-up in Standby feature set and required data is contained on the device media . The content of IDENTIFY DEVICE data word 0 and word 2 shall be valid.

Devices supporting the CFA feature set shall place the value 848Ah in word 0 . In this case, the above definitions for the bits in word 0 are not valid.

7.18.7.3 Word 1: Obsolete

7.18.7.4 Word 2: Specific configuration

Word 2 shall be set as defined in table 55.

Table 55 — Specific Configuration

Value	Description
37C8h	Device requires SET FEATURES subcommand to spin-up after power-up and IDENTIFY DEVICE data is incomplete (see 4.20).
738Ch	Device requires SET FEATURES subcommand to spin-up after power-up and IDENTIFY DEVICE data is complete (see 4.20).
8C73h	Device does not require SET FEATURES subcommand to spin-up after power-up and IDENTIFY DEVICE data is incomplete (see 4.20).
C837h	Device does not require SET FEATURES subcommand to spin-up after power-up and IDENTIFY DEVICE data is complete (see 4.20).
All other values	Reserved.

7.18.7.5 Word 3: Obsolete

7.18.7.6 Words 4..5: Retired

7.18.7.7 Word 6: Obsolete

7.18.7.8 Words 7..8: Reserved for assignment by the CompactFlash Association

7.18.7.9 Word 9: Retired

7.18.7.10 Words 10..19: Serial number

This field contains the serial number of the device . The contents of this field is an ATA string of twenty bytes in the format defined by 3.3.10 . The device shall pad the string with spaces (i.e., 20h), if necessary, to ensure that the string is the proper length . The combination of Serial number (i.e., words 10..19) and Model number (i.e., words 27..46) shall be unique for a given manufacturer.

7.18.7.11 Words 20..21: Retired

7.18.7.12 Word 22: Obsolete

7.18.7.13 Words 23..26: Firmware revision

This field contains the firmware revision of the device . The contents of this field is an ATA string of eight bytes in the format defined by 3.3.10 . The device shall pad the string with spaces (20h), if necessary, to ensure that the string is the proper length.

7.18.7.14 Words 27..46: Model number

This field contains the model number of the device . The contents of this field is an ATA string of forty bytes in the format defined by 3.3.10 . The device shall pad the string with spaces (i.e., 20h), if necessary, to ensure that the string is the proper length . The combination of Serial number (i.e., words 10..19) and Model number (i.e., words 27..46) shall be unique for a given manufacturer.

7.18.7.15 Word 47

Bits (7:0) of this word define the maximum number of logical sectors per DRQ data block that the device supports for READ/WRITE MULTIPLE commands.

For SATA devices, bits (7:0) shall be set to 16 or less.

7.18.7.16 Word 48: Trusted Computing feature set options

If bit 0 of word 48 is set to one, then the Trusted Computing feature set is supported.

7.18.7.17 Words 49..50: Capabilities

Bits (15:14) of word 49 are reserved for use in IDENTIFY PACKET DEVICE data (see table 64).

If bit 13 of word 49 is set to one, then table 67 shall define the Standby timer values used by the device . If bit 13 of word 49 is cleared to zero, then the timer values used by the device shall be vendor specific.

Bit 12 of word 49 is reserved for use in the IDENTIFY PACKET DEVICE data.

For PATA devices, if bit 11 of word 49 is set to one, then the device supports the IORDY signal (see ATA8-APT) . All PATA devices, except CFA-APT devices, shall set bit 11 of word 49 to one.

For SATA devices, bit 11 of word 49 shall be set to one.

For PATA devices, if bit 10 of word 49 is set to one, then the device supports the disabling of IORDY (see ATA8-APT) via the SET FEATURES command.

For SATA devices, bit 10 of word 49 shall be set to one.

Bit 9 of word 49 shall be set to one to indicate that LBA is supported .

If bit 8 of word 49 is set to one, then the device supports the DMA data transfer protocols . All devices, except CFA-APT devices, shall set this bit to one.

Bits (7:2) of word 49 are reserved.

If bit 13 of word 69 (see 7.18.7.30 and 7.50.18) is set to one, then if bits (1:0) of word 49 are:

  a) set to 00b, then Long Physical Sector Alignment Error reporting is disabled;
  b) set to 01b, then Long Physical Sector Alignment Error reporting is enabled;
  c) set to 10b, then the device shall report command aborted when an Alignment Error occurs; and
  d) set to 11b, then these bits are reserved.

Bit 15 of word 50 shall be cleared to zero.

Bit 14 of word 50 shall be set to one.

Bits (13:2) of word 50 are reserved.

Bit 1 of word 50 is obsolete.

If bit 0 of word 50 is set to one, then the device has a minimum Standby timer value that is vendor specific.

7.18.7.18 Words 51..52: Obsolete

7.18.7.19 Word 53

Bit 0 of word 53 is obsolete .

For PATA devices when bit 1 of word 53 is set to one, the values reported in words 64..70 are valid . If this bit is cleared to zero, the values reported in words 64..70 are not valid . All devices except CFA-APT devices shall support PIO mode 3 or above and shall set bit 1 of word 53 to one and support the fields contained in words 64..70.

For SATA devices, bit 1 of word 53 shall be set to one.

For PATA devices, if the device supports Ultra DMA and the values reported in word 88 are valid, then bit 2 of word 53 shall be set to one . If the device does not support Ultra DMA and the values reported in word 88 are not valid, then this bit shall be cleared to zero.

For SATA devices, bit 2 of word 53 shall be set to one.

7.18.7.20 Words 54..58: Obsolete

7.18.7.21 Word 59

If bit 15 of word 59 is set to one, then the device supports the Sanitize Device feature set OVERWRITE EXT command (see 7.43.4).

If bit 14 of word 59 is set to one, then the device supports the Sanitize Device feature set BLOCK ERASE EXT command (see 7.43.2).

If bit 13 of word 59 is set to one, then the device supports the Sanitize Device feature set CRYPTO SCRAMBLE EXT command (see 7.43.3).

If bit 12 of word 59 is set to one the device supports the Sanitize Device feature set.

If bit 8 of word 59 is set to one, then bits (7:0) indicate the number of logical sectors that shall be transferred per DRQ data block for a READ MULTIPLE command or a WRITE MULTIPLE command . This default setting of this field is the optimum value for the device (see 7.53).

7.18.7.22 Words 60..61: Total number of user addressable logical sectors for 28-bit commands

This field contains a value that is one greater than the maximum user addressable LBA . The maximum value that shall be placed in this field is 0FFF_FFFFh . If this field contains 0FFF_FFFFh and the device has user addressable LBAs greater than or equal to 0FFF_FFFFh, then words 100..103 contain the total number of user addressable LBAs (see 4.12.4).

7.18.7.23 Word 62: Obsolete

7.18.7.24 Word 63

Word 63 identifies the Multiword DMA transfer modes supported by the device and indicates the mode that is currently selected . Only one DMA mode shall be selected at any given time . If an Ultra DMA mode is enabled, then no Multiword DMA mode shall be enabled . If a Multiword DMA mode is enabled, then no Ultra DMA mode shall be enabled.

Bits (15:11) of word 63 are reserved.

If bit 10 of word 63 is set to one, then Multiword DMA mode 2 is selected . If this bit is cleared to zero, then Multiword DMA mode 2 is not selected . If bit 9 is set to one or if bit 8 is set to one, then this bit shall be cleared to zero.

If bit 9 of word 63 is set to one, then Multiword DMA mode 1 is selected . If this bit is cleared to zero, then Multiword DMA mode 1 is not selected . If bit 10 is set to one or if bit 8 is set to one, then this bit shall be cleared to zero.

If bit 8 of word 63 is set to one, then Multiword DMA mode 0 is selected . If this bit is cleared to zero, then Multiword DMA mode 0 is not selected . If bit 10 is set to one or if bit 9 is set to one, then this bit shall be cleared to zero.

Bits (7:3) of word 63 are reserved.

For PATA devices, if bit 2 of word 63 is:

    a) set to one, then Multiword DMA modes 2 and below are supported (i.e., if Multiword DMA mode 2 is supported, then Multiword DMA modes 1 and 0 shall be supported);
    b) cleared to zero, then Multiword DMA mode 2 is not supported; and
    c) set to one, then bit 0 of word 63 shall be set to one and bit 1 of word 63 shall be set to one.

For SATA devices, bit 2 of word 63 shall be set to one.

For PATA devices, if bit 1 of word 63 is:

    a) set to one, then Multiword DMA modes 1 and below are supported (i.e., if Multiword DMA mode 1 is supported, then Multiword DMA mode 0 shall also be supported);
    b) cleared to zero, then Multiword DMA mode 1 is not supported; and
    c) set to one, then bit 0 of word 63 shall be set to one.

For SATA devices, bit 1 of word 63 shall be set to one.

For PATA devices, if bit 0 of word 63 is set to one, then Multiword DMA mode 0 is supported.

For SATA devices, bit 0 of word 63 shall be set to one.

7.18.7.25 Word 64

For PATA devices bits (7:0) of word 64 is defined as the PIO data and register transfer supported field . If word 64 is supported, bit 1 of word 53 shall be set to one . This field is bit significant . Any number of bits may be set to one in this field by the device to indicate the PIO modes the device is capable of supporting.

Of these bits, bits (7:2) are reserved for future PIO modes . Bit 0, if set to one, indicates that the device supports PIO mode 3 . All devices except CFA-APT devices shall support PIO mode 3 and shall set bit 0 to one . Bit 1, if set to one, indicates that the device supports PIO mode 4 . See ATA8-APT for more information.

For SATA devices bits (1:0) shall be set to one.

7.18.7.26 Word 65: Minimum Multiword DMA transfer cycle time per word

For PATA devices word 65 is defined as the minimum Multiword DMA transfer cycle time per word . This field defines, in nanoseconds, the minimum cycle time that the device supports when performing Multiword DMA transfers on a per word basis.

For SATA devices word 65 shall be set to indicate 120ns.

If word 65 is supported, bit 1 of word 53 shall be set to one . Any device that supports Multiword DMA mode 1 or above shall support this field, and the value in word 65 shall not be less than the minimum cycle time for the fastest DMA mode supported by the device.

If bit 1 of word 53 is set to one because a device supports a field in words 64..70 other than this field and the device does not support this field, then the device shall return a value of zero in this field.

7.18.7.27 Word 66: Device recommended Multiword DMA transfer cycle time

For PATA devices:

a) word 66 contains the Multiword DMA transfer cycle time recommended by the device in nanoseconds (i.e., the minimum cycle time per word during a single logical sector host transfer while performing a multiple logical sector READ DMA or WRITE DMA command for any location on the media under nominal conditions);
b) if this field is supported, then bit 1 of word 53 shall be set to one;
c) any device that supports Multiword DMA mode 1 or above shall support this field;
d) the value in word 66 shall not be less than the value in word 65;
e) if bit 1 of word 53 is set to one because a device supports a field in words 64..70 other than this field, and the device does not support word 66, then the device shall return a value of zero in word 66; and
f) if a host runs at a faster cycle rate by operating at a cycle time of less than this value, then the device may negate DMARQ for flow control . The rate at which DMARQ is negated may result in reduced throughput despite the faster cycle rate . Transfer at this rate does not ensure that flow control is not used, but implies that higher performance may result (see ATA8-APT).

For SATA devices, word 66 shall be set to 78h to indicate 120 ns.

7.18.7.28 Word 67: Minimum PIO transfer cycle time without IORDY flow control

For PATA devices word 67 is defined as the minimum PIO transfer without IORDY (see ATA8-APT) flow control cycle time . This field defines, in nanoseconds, the minimum cycle time that, if used by the host, the device guarantees data integrity during the transfer without utilization of IORDY (see ATA8-APT) flow control .

For SATA devices word 67 shall be set to indicate 120 ns.

If word 67 is supported, bit 1 of word 53 shall be set to one.

Any device that supports PIO mode 3 or above shall support this field, and the value in word 67 shall not be less than the value reported in word 68.

If bit 1 of word 53 is set to one because a device supports a field in words 64..70 other than this field and the device does not support this field, then the device shall return a value of zero in this field.

7.18.7.29 Word 68: Minimum PIO transfer cycle time with IORDY flow control

For PATA devices word 68 is defined as the minimum PIO transfer with IORDY (see ATA8-APT) flow control cycle time . This field defines, in nanoseconds, the minimum cycle time that the device supports while performing data transfers while utilizing IORDY (see ATA8-APT) flow control.

For SATA devices word 68 shall be set to indicate 120 ns.

If word 68 is supported, bit 1 of word 53 shall be set to one.

All devices except CFA-APT devices shall support PIO mode 3 and shall support this field, and the value in word 68 shall be the fastest defined PIO mode supported by the device . The maximum value reported in this field shall be 180 (i.e., PIO mode 3 or above).

If bit 1 of word 53 is set to one because a device supports a field in words 64..70 other than this field and the device does not support this field, then the device shall return a value of zero in this field.

7.18.7.30 Word 69: Additional Supported

Word 69 shall indicate features and command sets supported . If a defined bit is cleared to zero, the indicated features and command set is not supported . These features and command sets are enabled and there is no disable mechanism.

If bit 15 of word 69 is set to one, then the device supports the CFast specification.

If word 169 bit 0 is set to one and word 69 bit 14 is cleared to zero, then the Trim function of the DATA SET MANAGEMENT command (see 7.10.3.2) supports indeterminate read after trim behavior . If word 169 bit 0 is set to one and word 69 bit 14 is set to one, the Trim function of the DATA SET MANAGEMENT command supports determinate read after trim behavior . If word 169 bit 0 is cleared to zero, then word 69 bit 14 is reserved.

If bit 13 of word 69 is set to one, then the device supports the SET FEATURES command with the Long Physical Sector Alignment Error Reporting Control subcommand (see 7.50.18).

If bit12 of word 69 is set to one, then the DEVICE CONFIGURATION IDENTIFY DMA command and DEVICE CONFIGURATION SET DMA command are supported.

If bit 11 of word 69 is set to one, then the READ BUFFER DMA command is supported.

If bit 10 of word 69 is set to one, then the WRITE BUFFER DMA command is supported.

If bit 9 of word 69 is set to one, then the SET MAX SET PASSWORD DMA command and SET MAX UNLOCK DMA command are supported.

If bit 8 of word 69 is set to one, then the DOWNLOAD MICROCODE DMA command is supported.

Bit 7 is reserved for IEEE 1667

Bit 6 of word 69 shall be cleared to zero if the following commands are supported:

    a) FLUSH CACHE;
    b) READ DMA;
    c) READ MULTIPLE;
    d) READ SECTOR(S);
    e) READ VERIFY SECTOR(S);
    f) SET MULTIPLE MODE;
    g) WRITE DMA;
    h) WRITE MULTIPLE; and
    i) WRITE SECTOR(S).

Bit 6 of word 69 shall be set to one if any of the following commands are not supported:

    a) FLUSH CACHE;
    b) READ DMA;

c)   READ MULTIPLE;
d)   READ SECTOR(S);
e)   READ VERIFY SECTOR(S);
f)   SET MULTIPLE MODE;
g)   WRITE DMA;
h)   WRITE MULTIPLE; or
i)   WRITE SECTOR(S).

If word 69 bit 14 is set to one and word 69 bit 5 is set to one, then a read operation after a Trim operation returns data from trimmed LBAs as all words cleared to zero . If word 69 bit 14 is set to one and word 69 bit 5 is cleared to zero, then a read operation after a Trim operation may have words set to any value . If word 69 bit 14 is cleared to zero, then word 69 bit 5 is reserved.

If word 69 bit 4 is set to one, then words 230..233 (see 7.18.7.89) are valid . If word 69 bit 4 is cleared to zero, then words 230..233 (see 7.18.7.89) are reserved.

Bits (3:0) of word 69 are reserved.

7.18.7.31 Word 70: Reserved

7.18.7.32 Words 71..74: Reserved for ATAPI

7.18.7.33 Word 75: Queue depth

Bits (4:0) of word 75 indicate the maximum queue depth supported by the device . The queue depth includes all commands for which command acceptance has occurred and command completion has not occurred . The value in this field shall be set to one less than the maximum queue depth (e.g., a value of zero in this field indicates a queue depth of one, and a value of 31 in this field indicates a queue depth of 32) . If bit 6 of word 76 is cleared to zero indicating that the device does not support NCQ feature set commands, then the value in this field shall be zero . Support of this word is mandatory if the NCQ feature set is supported.

7.18.7.34 Word 76: Serial ATA Capabilities

Word 76 indicates the capabilities of a SATA device . A PATA device shall set word 76 to 0000h or FFFFh . If word 76 is set to 0000h or FFFFh, then the device does not claim compliance with the Serial ATA specification and words 76 through 79 are not valid and shall be ignored.

If word 76 is not set to 0000h or FFFFh, then the device claims compliance with the Serial ATA specification, and words 77 through 79 shall be valid.

Bits (15:13) of word 76 are reserved for Serial ATA.

If bit 12 of word 76 is set to one, then the device supports the Priority field in the READ FPDMA QUEUED command and WRITE FPDMA QUEUED command and optimization based on this information . This bit shall only be set to one if the device supports NCQ as shown in bit 8 of Word 76.

If bit 11 of word 76 is set to one, then the device supports moving the heads to a safe position upon reception of the IDLE IMMEDIATE command with the Unload Feature specified while NCQ commands are outstanding . This bit shall only be set to one if the device supports NCQ as shown in bit 8 of Word 76.

If bit 10 of word 76 is set to one, then the device supports the SATA Phy Event Counters log (see A.14).

If bit 9 of word 76 is set to one, then the device supports Partial and Slumber interface power management states when initiated by the host (see SATA 2.6).

If bit 8 of word 76 is set to one, then the device supports the NCQ feature set.

Bits (7:3) of word 76 are reserved for Serial ATA.

If bit 2 of word 76 is set to one, then the device supports the Gen2 signaling rate of 3.0 Gb/s (see SATA 2.6).

If bit 1 of word 76 is set to one, then the device supports the Gen1 signaling rate of 1.5 Gb/s (see SATA 2.6).

Bit 0 of word 76 shall be cleared to zero.

7.18.7.35 Word 77: Reserved for Serial ATA

Word 77 is reserved for Serial ATA definition and shall be cleared to zero.

7.18.7.36 Word 78: Serial ATA features supported

If Word 76 is not 0000h or FFFFh, Word 78 reports the optional features supported by the device . If this word is not supported the word shall be cleared to zero.

Bits (15:7) are reserved for Serial ATA.

If bit 6 is set to one, then the device supports the SSP feature set (see 4.25).

Bit 5 is reserved for Serial ATA.

If bit 4 is set to one the device supports guaranteed in-order data delivery when non-zero buffer offsets are used for commands in the NCQ feature set . See SATA 2.6 for more information.

If bit 3 is set to one the device supports device initiated power management requests . If bit 3 is cleared to zero the device does not support device initiated power management requests . A device may support reception of power management requests initiated by the host as described in the definition of bit 9 of Word 76 without supporting initiating such power management requests as indicated by this bit.

If bit 2 is set to one the device supports the use of the DMA Setup FIS Auto-Activate optimization . See SATA 2.6 for more information.

If bit 1 is set to one the device supports the use of non-zero buffer offsets for commands in the NCQ feature set . See SATA 2.6 for more information.

Bit 0 shall be cleared to zero.

7.18.7.37 Word 79: Serial ATA features enabled

If Word 76 is not 0000h or FFFFh, Word 79 reports which optional features supported by the device are enabled . This word shall be supported if Word 78 is supported and shall not be supported if Word 78 is not supported.

Bits (15:7) are reserved for Serial ATA.

If bit 6 is set to one, then the SSP feature set is enabled . If the device supports the SSP feature set, then this field shall be one after a power on reset has been processed . If the device does not support the SSP feature set, then this field shall be zero by default.

Bit 5 is reserved for Serial ATA.

If bit 4 is set to one, then device support for guaranteed in-order data delivery when non-zero buffer offsets are used for commands in the NCQ feature set is enabled . See SATA 2.6 for more information.

If bit 3 is set to one, then device support for initiating power management requests to the host is enabled . When set to one the device may initiate power management transition requests . When cleared to zero the device shall not initiate interface power management requests to the host . This field shall be zero by default.

If bit 2 is set to one, then the device support for use of the DMA Setup FIS Auto-Activate optimization is enabled . See SATA 2.6 for more information.

If bit 1 is set to one, then device support for the use of non-zero buffer offsets for commands in the NCQ feature set is enabled . See SATA 2.6 for more information.

Bit 0 shall be cleared to zero.

7.18.7.38 Word 80: Major version number

If word 80 is not set to 0000h or FFFFh, then the device claims compliance with the major version(s) as indicated by bits (8:4) being set to one . Values other than 0000h and FFFFh are bit significant . A device may set more than one bit.

7.18.7.39 Word 81: Minor version number

Table 56 defines the value that shall be reported in word 81 to indicate the version of the standard that guided the implementation.

Table 56 — Minor version number (part 1 of 2)

Value	Minor Version
0000h	Minor version is not reported
0001h	Obsolete
0002h	Obsolete
0003h	Obsolete
0004h	Obsolete
0005h	Obsolete
0006h	Obsolete
0007h	Obsolete
0008h	Obsolete
0009h	Obsolete
000Ah	Obsolete
000Bh	Obsolete
000Ch	Obsolete
000Dh	Obsolete
000Eh	Obsolete
000Fh	Obsolete
0010h	Obsolete
0011h	Obsolete
0012h	Obsolete
0013h	ATA/ATAPI-5 T13 1321D version 3
0014h	Obsolete
0015h	ATA/ATAPI-5 T13 1321D version 1
0016h	ATA/ATAPI-5 published, ANSI INCITS 340-2000
0017h	Obsolete
0018h	ATA/ATAPI-6 T13 1410D version 0
0019h	ATA/ATAPI-6 T13 1410D version 3a
001Ah	ATA/ATAPI-7 T13 1532D version 1
001Bh	ATA/ATAPI-6 T13 1410D version 2
001Ch	ATA/ATAPI-6 T13 1410D version 1
001Dh	ATA/ATAPI-7 published ANSI INCITS 397-2005.
001Eh	ATA/ATAPI-7 T13 1532D version 0
001Fh	Reserved
0020h	Reserved
0021h	ATA/ATAPI-7 T13 1532D version 4a
0022h	ATA/ATAPI-6 published, ANSI INCITS 361-2002

Table 56 — Minor version number (part 2 of 2)

Value	Minor Version
0023h..0026h	Reserved
0027h	ATA8-ACS version 3c
0028h	ATA8-ACS version 6
0029h	ATA8-ACS version 4
0030h	Reserved
0031h	ASC-2 Revision 2
0032h	Reserved
0033h	ATA8-ACS version 3e
0034h..0038h	Reserved
0039h	ATA8-ACS version 4c
0040h..0041h	Reserved
0042h	ATA8-ACS version 3f
0043h..0051h	Reserved
0052h	ATA8-ACS version 3b
0053h..0106h	Reserved
0107h	ATA8-ACS version 2d
0108h..010Fh	Reserved
0110h	ACS-2 Revision 3
0111h..FFFEh	Reserved
FFFFh	Minor version is not reported

7.18.7.40 Words 82..84, 119: Commands and feature sets supported

Words 82..84 and 119 shall indicate features and command sets supported . If a defined bit is cleared to zero, the indicated features and command set is not supported . If bit 14 of word 83 is set to one and bit 15 of word 83 is cleared to zero, then the contents of words 82..83 contain valid support information . Otherwise, support information is not valid in these words . If bit 14 of word 84 is set to one and bit 15 of word 84 is cleared to zero, then the contents of word 84 contains valid support information . Otherwise, support information is not valid in this word . If bit 14 of word 119 is set to one and bit 15 of word 119 is cleared to zero, then the contents of word 119 contains valid support information . Otherwise, support information is not valid in word 119.

Bit 15 of word 82 is obsolete.

If bit 14 of word 82 is set to one, then the NOP command (see 7.23) is supported.

If bit 13 of word 82 is set to one, then the READ BUFFER command is supported.

If bit 12 of word 82 is set to one, then the WRITE BUFFER command is supported.

Bit 11 of word 82 is obsolete.

If bit 10 of word 82 is set to one, then the HPA feature set is supported.

Bit 9 shall be cleared to zero to indicate that the DEVICE RESET command is not supported.

bits 8:7 of word 82 are obsolete

If bit 6 of word 82 is set to one, then read look-ahead is supported.

If bit 5 of word 82 is set to one, then volatile write cache is supported.

Bit 4 of word 82 shall be cleared to zero to indicate that this is not an ATAPI device.

If bit 3 of word 82 is set to one, then the Power Management feature set is supported.

Bit 2 of word 82 is obsolete.

If bit 1 of word 82 is set to one, then the Security feature set is supported.

If bit 0 of word 82 is set to one, then the SMART feature set is supported.

If bit 13 of word 83 is set to one, then the FLUSH CACHE EXT command is supported.

Bit 12 of word 83 shall be set to one indicating the device supports the mandatory FLUSH CACHE command.

If bit 11 of word 83 is set to one, then the DCO feature set is supported.

If bit 10 of word 83 is set to one, then the 48-bit Address feature set is supported.

If bit 9 of word 83 is set to one, then the AAM feature set is supported.

If bit 8 of word 83 is set to one, then the HPA Security Extensions (see 4.12.2) are supported.

Bit 7 of word 83 is reserved for Address Offset Reserved Area Boot Method

If bit 6 of word 83 is set to one, then the device requires the SET FEATURES subcommand to spin-up after power-up if the PUIS feature set is enabled (see 7.50.8).

If bit 5 of word 83 is set to one, then the PUIS feature set is supported.

Bit 4 of word 83 is obsolete.

If bit 3 of word 83 is set to one, then the APM feature set is supported.

If bit 2 of word 83 is set to one, then the CFA feature set is supported.

Bit 1 of word 83 is obsolete.

If bit 0 of word 83 is set to one, then the DOWNLOAD MICROCODE command is supported.

If bit 13 of word 84 is set to one, then the IDLE IMMEDIATE command with unload feature is supported.

Bit 12 of word 84 is reserved for TLC.

Bit 11 of word 84 is reserved for TLC.

Bits (10:9) are Obsolete

Bit 8 of word 84 shall be set to one indicating the mandatory World Wide Name in words 108..111 is supported.

Bit 7 of word 84 is obsolete.

If bit 10 of word 83 is set to one, then bit 6 of word 84 shall be set to one to indicate that the WRITE DMA FUA EXT command and WRITE MULTIPLE FUA EXT command are supported . If bit 10 of word 83 is cleared to zero, then bit 6 of word 84 shall be cleared to zero.

If bit 5 of word 84 is set to one, then the GPL feature set is supported.

If bit 4 of word 84 is set to one, then the Streaming feature set is supported.

If bit 3 of word 84 is set to one, then the Media Card Pass Through Command feature set is supported.

If bit 2 of word 84 is set to one, then the media serial number field in words 176..205 is supported.

If bit 1 of word 84 is set to one, SMART self-test is supported . This bit is valid if bit 0 of word 82 is set to one indicating that the SMART feature set is supported.

If bit 0 of word 84 is set to one, SMART error logging is supported . This bit is valid if bit 0 of word 82 is set to one indicating that the SMART feature set is supported.

Bits (13:8) of word 119 are reserved.

If bit 7 of word 119 is set to one, then the Extended Power Conditions feature is supported (see 7.50.19).

If bit 6 of word 119 is set to one, then the Sense Data Reporting feature set is supported.

If bit 5 of word 119 is set to one, then the Free-fall Control feature set is supported.

If bit 4 of word 119 is set to one, then the DOWNLOAD MICROCODE command requesting the offset transfer method is supported.

If bit 3 of word 119 is set to one, then the READ LOG DMA EXT command and WRITE LOG DMA EXT command are supported . This bit shall only be set to one if word 84 bit 5 is set to one.

If bit 2 of word 119 is set to one, then the WRITE UNCORRECTABLE EXT command is supported.

If bit 1 of word 119 is set to one, then the Write-Read-Verify feature set is supported.

Bit 0 of word 119 is reserved for DDT.

7.18.7.41 Words 85..87, 120: Commands and feature sets supported or enabled

Words 85..87 and 120 shall indicate features and command sets enabled . If a defined bit is cleared to zero, the indicated features and command set is not enabled . If a supported feature or feature set is supported and there is no defined method to disable the feature or feature set, then it is defined as supported and the bit shall be set to one . If bit 14 of word 87 is set to one and bit 15 of word 87 is cleared to zero, then the contents of words 85..87 contain valid information . If bit 14 of word 120 is set to one and bit 15 of word 120 is cleared to zero, then the contents of word 120 contain valid information . Otherwise, information is not valid in these words.

> NOTE 12 — Some features do not have a method to be disabled . These features are marked as supported in this subclause for symmetry.

Bit 14 of word 85 is a copy of bit 14 of word 82.

Bit 13 of word 85 is a copy of bit 13 of word 82.

Bit 12 of word 85 is a copy of bit 12 of word 82.

Bit 10 of word 85 is a copy of bit 10 of word 82.

Bit 9 of word 85 shall be cleared to zero to indicate that the DEVICE RESET command is not supported.

Bits 8:7 of word 85 are obsolete.

If bit 6 of word 85 is set to one, then read look-ahead is enabled (see 7.50.13) . If bit 6 of word 85 is cleared to zero, then read look-ahead is disabled . This bit is valid if bit 6 of word 82 is set to one indicating read look-ahead is supported.

If bit 5 of word 85 is set to one, then volatile write cache is enabled (see 7.50.4) . If bit 5 of word 85 is cleared to zero, then volatile write cache is disabled . This bit is valid if bit 5 of word 82 is set to one indicating write cache is supported.

Bit 4 of word 85 is a copy of bit 4 of word 82.

Bit 3 of word 85 is a copy of bit 3 of word 82.

If bit 1 of word 85 is set to one, then security has been enabled by setting a User password via the SECURITY SET PASSWORD command . If bit 1 of word 85 is cleared to zero, then there is no valid User password . If the Security feature set is not supported, then this bit shall be cleared to zero . This bit is valid if bit 1 of word 82 is set to one indicating Security feature set is supported.

If bit 0 of word 85 is set to one, then the SMART feature set is enabled (see 7.55.4) . If bit 0 of word 85 is cleared to zero, then the SMART feature set is disabled (see 7.55.2) . This bit is valid if bit 0 of word 82 is set to one indicating SMART feature set is supported.

If bit 15 of word 86 is set to one, then words 119 and 120 are valid.

Bit 14 of word 86 is reserved.

Bit 13 of word 86 is a copy of bit 13 of word 83.

Bit 12 of word 86 is a copy of bit 12 of word 83.

Bit 11 of word 86 is a copy of bit 11 of word 83.

Bit 10 of word 86 is a copy of bit 10 of word 83.

If bit 9 of word 86 is set to one, then the Automatic Acoustic Management feature set is enabled (see 7.50.11) and the value in word 94 is valid . This bit is valid if bit 9 of word 83 is set to one indicating that the AAM feature set is supported.

If bit 8 of word 86 is set to one, then the HPA Security Extensions are enabled (see 7.51.5) . This bit is valid if bit 8 of word 83 is set to one indicating the HPA Security Extensions are supported.

Bit 7 of word 86 is reserved for Address Offset Reserved Area Boot Method.

Bit 6 of word 86 is a copy of bit 6 of word 83.

If bit 5 of word 86 is set to one, then the PUIS feature set is enabled (see 7.50.7) . If bit 5 of word 86 is cleared to zero, then the PUIS feature set is disabled . This bit is valid if bit 5 of word 83 is set to one indicating PUIS feature set is supported.

If bit 3 of word 86 is set to one, then the APM feature set is enabled (see 7.50.6) . If bit 3 of word 86 is cleared to zero, the APM feature set is disabled.

Bit 2 of word 86 is a copy of bit 2 of word 83.

Bit 1 of word 86 is obsolete.

Bit 0 of word 86 is a copy of bit 0 of word 83.

Bit 13 of word 87 is a copy of bit 13 of word 84.

Bit 12 of word 87 is reserved for TLC.

Bit 11 of word 87 is reserved for TLC .

Bit 8 of word 87 is a copy of word 84 bit 8.

Bit 7 of word 87 is obsolete.

Bit 6 of word 87 is a copy of bit 6 of word 84.

Bit 5 of word 87 is a copy of bit 1 of word 84.

If bit 3 of word 87 is set to one, then the Media Card Pass Through feature set is enabled . If bit 3 of word 87 is cleared to zero, then the Media Card Pass Through feature set is disabled.

If bit 2 of word 87 is set to one, then the media serial number field in words 176..205 is valid . This bit shall be cleared to zero if the media does not contain a valid serial number or if no media is present . This bit is valid if bit 2 of word 84 is set to one indicating Media serial number is supported.

Bit 1 of word 87 is a copy of bit 1 of word 84.

Bit 0 of word 87 is a copy of bit 0 of word 84.

Bits (13:8) of word 120 are reserved.

If any Extended Power Conditions subcommand (see 7.50.19) has been processed without error since the last power cycle, then bit 7 of word 120 shall be set to one . If no Extended Power Conditions subcommand has been processed without error since the last power cycle, then bit 7 of word 120 shall be cleared to zero . This bit is valid if word 119 bit 7 is set to one.

If bit 6 of word 120 is set to one, then the Sense Data Reporting feature set is enabled.

If bit 5 of word 120 is set to one, then the Free-fall Control feature set is enabled . If bit 5 of word 120 is cleared to zero, then the Free-fall Control feature set is disabled.

Bit 4 of word 120 is a copy of bit 4 of word 119.

Bit 3 of word 120 is a copy of bit 3 of word 119.

Bit 2 of word 120 is a copy of bit 2 of word 119.

If bit 1 of word 120 is set to one, then the Write-Read-Verify feature set is enabled . If bit 1 of word 120 is cleared to zero, then the Write-Read-Verify feature set is disabled.

Bit 0 of word 120 is reserved for DDT.

7.18.7.42 Word 88: Ultra DMA modes

Word 88 identifies the Ultra DMA transfer modes supported by the device and indicates the mode that is currently selected . Only one DMA mode shall be selected at any given time . If an Ultra DMA mode is selected, then no Multiword DMA mode shall be selected . If a Multiword DMA mode is selected, then no Ultra DMA mode shall be selected . Support of this word is mandatory if any Ultra DMA mode is supported.

Bit 15 of word 88 is reserved.

If bit 14 of word 88 is set to one, then Ultra DMA mode 6 is selected . If this bit is cleared to zero, then Ultra DMA mode 6 is not selected . If bit 13 or bit 12 or bit 11 or bit 10 or bit 9 or bit 8 is set to one, then this bit shall be cleared to zero.

If bit 13 of word 88 is set to one, then Ultra DMA mode 5 is selected . If this bit is cleared to zero, then Ultra DMA mode 5 is not selected . If bit 14 or bit 12 or bit 11 or bit 10 or bit 9 or bit 8 is set to one, then this bit shall be cleared to zero.

If bit 12 of word 88 is set to one, then Ultra DMA mode 4 is selected . If this bit is cleared to zero, then Ultra DMA mode 4 is not selected . If bit 14 or bit 13 or bit 11 or bit 10 or bit 9 or bit 8 is set to one, then this bit shall be cleared to zero.

If bit 11 of word 88 is set to one, then Ultra DMA mode 3 is selected . If this bit is cleared to zero, then Ultra DMA mode 3 is not selected . If bit 14 or bit 13 or bit 12 or bit 10 or bit 9 or bit 8 is set to one, then this bit shall be cleared to zero.

If bit 10 of word 88 is set to one, then Ultra DMA mode 2 is selected . If this bit is cleared to zero, then Ultra DMA mode 2 is not selected . If bit 14 or bit 13 or bit 12 or bit 11 or bit 9 or bit 8 is set to one, then this bit shall be cleared to zero.

If bit 9 of word 88 is set to one, then Ultra DMA mode 1 is selected . If this bit is cleared to zero, then Ultra DMA mode 1 is not selected . If bit 14 or bit 13 or bit 12 or bit 11 or bit 10 or bit 8 is set to one, then this bit shall be cleared to zero.

If bit 8 of word 88 is set to one, then Ultra DMA mode 0 is selected . If this bit is cleared to zero, then Ultra DMA mode 0 is not selected . If bit 14 or bit 13 or bit 12 or bit 11 or bit 10 or bit 9 is set to one, then this bit shall be cleared to zero.

Bit 7 of word 88 is reserved.

For PATA devices when bit 6 of word 88 is set to one Ultra DMA modes 6 and below are supported . If this bit is cleared to zero, then Ultra DMA mode 6 is not supported . If Ultra DMA mode 6 is supported, then Ultra DMA modes 5, 4, 3, 2, 1 and 0 shall also be supported . If this bit is set to one, then bits (5:0) shall be set to one.

For SATA devices bit 6 of word 88 shall be set to one.

For PATA devices when bit 5 of word 88 is set to one Ultra DMA modes 5 and below are supported . If this bit is cleared to zero, then Ultra DMA mode 5 is not supported . If Ultra DMA mode 5 is supported, then Ultra DMA modes 4, 3, 2, 1 and 0 shall also be supported . If this bit is set to one, then bits (4:0) shall be set to one.

For SATA devices bit 5 of word 88 shall be set to one.

For PATA devices when bit 4 of word 88 is set to one Ultra DMA modes 4 and below are supported . If this bit is cleared to zero, then Ultra DMA mode 4 is not supported . If Ultra DMA mode 4 is supported, then Ultra DMA modes 3, 2, 1 and 0 shall also be supported . If this bit is set to one, then bits (3:0) shall be set to one.

For SATA devices bit 4 of word 88 shall be set to one.

For PATA devices when bit 3 of word 88 is set to one Ultra DMA modes 3 and below are supported . If this bit is cleared to zero, then Ultra DMA mode 3 is not supported . If Ultra DMA mode 3 is supported, then Ultra DMA modes 2, 1 and 0 shall also be supported . If this bit is set to one, then bits (2:0) shall be set to one.

For SATA devices bit 3 of word 88 shall be set to one.

For PATA devices when bit 2 of word 88 is set to one Ultra DMA modes 2 and below are supported . If this bit is cleared to zero, then Ultra DMA mode 2 is not supported . If Ultra DMA mode 2 is supported, then Ultra DMA modes 1 and 0 shall also be supported . If this bit is set to one, bits (1:0) shall be set to one.

For SATA devices bit 2 of word 88 shall be set to one.

For PATA devices when bit 1 of word 88 is set to one Ultra DMA modes 1 and below are supported . If this bit is cleared to zero, then Ultra DMA mode 1 is not supported . If Ultra DMA mode 1 is supported, then Ultra DMA mode 0 shall also be supported . If this bit is set to one, bit 0 shall be set to one.

For SATA devices bit 1 of word 88 shall be set to one.

For PATA devices when bit 0 of word 88 is set to one Ultra DMA mode 0 is supported . If this bit is cleared to zero, then Ultra DMA is not supported.

For SATA devices bit 0 of word 88 shall be set to one.

7.18.7.43 Word 89

Word 89 specifies the estimated time required for the SECURITY ERASE UNIT command to complete its normal mode erasure as defined in table 57 . Support of this word is mandatory if the Security feature set is supported . If the Security feature set is not supported, this word shall be cleared to zero.

Table 57 — Normal Erase Mode Time

Value	Time
0	Value not specified
1..254	(Value*2) minutes
255	>508 minutes

7.18.7.44 Word 90

Word 90 specifies the estimated time required for the SECURITY ERASE UNIT command to complete its enhanced mode erasure as defined in table 58 . Support of this word is mandatory if support of the Security feature set is supported . If the Security feature set is not supported, this word shall be cleared to zero.

Table 58 — Enhanced Erase Mode Time

Value	Time
0	Value not specified
1..254	(Value*2) minutes
255	>508 minutes

7.18.7.45 Word 91: Current advanced power management level value

Bits (7:0) of word 91 contain the current APM level setting (see table 124) . Support of this word is mandatory if the APM feature set is supported . This word is valid if bit 3 of word 83 and bit 3 of word 86 are set to one indicating the APM feature set is supported.

7.18.7.46 Word 92: Master Password Identifier

If the Security feature set is not supported (i.e., bit 1 of word 82 is cleared to zero) or the Master Password Identifier feature is not supported, then word 92 shall contain 0000h or FFFFh.

If the Security feature set and the Master Password Identifier feature are supported, then word 92 contains the value of the Master Password Identifier set when the Master Password was last changed.

7.18.7.47 Word 93: Hardware reset results

For PATA devices, when bit 14 of word 93 is set to one and bit 15 of word 93 is cleared to zero the content of word 93 contains valid information . During processing of a hardware reset, Device 0 shall set bits (12:8) of this word to zero and shall set bits (7:0) of this word to show the result of the hardware reset . During processing of a hardware reset, Device 1 shall clear bits (7:0) of this word to zero and shall set bits (12:8) of the word to show the result of the hardware reset . The contents of bits (12:0) of this word shall change only during the processing of a hardware reset.

Bit 13 shall be set or cleared by the selected device to indicate whether the device detected the CBLID- signal (see ATA8-APT) above V_{IH} or the CBLID- signal below V_{IL} at any time during the processing of each IDENTIFY DEVICE command after receiving the command from the host but before returning data to the host . This test may be repeated by the device during command processing (see ATA8-APT).

For SATA devices, word 93 shall be set to the value 0000h.

7.18.7.48 Word 94: Current AAM value

Bits (15:8) contain the device vendor's recommended AAM level (see table 126) . If the host requires the device to perform with highest performance, then the host should set the AAM level to FEh (see 7.50.11) . If the host requires the device vendor's recommended AAM level, then the host should set the AAM level to the value returned in these bits . Support of this word is mandatory if the AAM feature set is supported.

> NOTE 13 — The use of this setting may not provide the lowest acoustics, or the best trade-off of acoustics and performance, in all configurations.

Bits (7:0) contain the current AAM level . If the AAM feature set is supported by the device, but the level has not been set by the host, then this byte shall contain the device's default setting . If the AAM feature set is not supported by the device, then the value of this byte shall be zero.

This word is valid if bit 9 of word 83 is set to one indicating that the AAM feature set is supported.

7.18.7.49 Word 95: Stream Minimum Request Size

Word 95 contains the number of logical sectors that provides optimum performance in a streaming environment . This number shall be a power of two, with a minimum of eight logical sectors . The starting LBA value for each streaming command should be evenly divisible by this request size . This word is valid if bit 4 of word 84 is set to one, indicating that the Streaming feature set is supported . If the Streaming feature set is not supported by the device, then the content of word 95 shall be zero.

7.18.7.50 Word 96: Streaming Transfer Time - DMA

Word 96 defines the Streaming Transfer Time for DMA mode . The worst-case sustainable transfer time per logical sector for the device is calculated as follows:

$$\text{Worst Case Sustainable Transfer Time} = \frac{x \times y}{65\ 536}$$

Where:

      x = Streaming Performance Granularity (see 7.18.7.52); and
      y = Streaming Transfer Time for DMA mode.

The content of word 96 may be affected by the host issuing a Set Maximum Host Interface Sector Times (see 7.50.12) . As a result, the host should issue an IDENTIFY DEVICE command after issuing a SET FEATURES command that may affect this word . If the Streaming feature set is not supported by the device, then the content of word 96 shall be zero.

This word is valid if bit 4 of word 84 is set to one indicating that the Streaming feature set is supported.

7.18.7.51 Word 97: Streaming Access Latency - DMA and PIO

Word 97 defines the Streaming Access Latency for DMA and PIO mode . The worst-case access latency of the device for a streaming command is calculated as follows:

$$\text{Worst Case Access Latency} = \frac{x \times y}{256}$$

Where:

      x = Streaming Performance Granularity (see 7.18.7.52); and
      y = Streaming Access Latency for DMA and PIO mode.

The content of word 97 may be affected by the host issuing a SET FEATURES subcommand 42h or C2h (i.e., enabling or disabling AAM) . As a result, the host should issue an IDENTIFY DEVICE command after issuing a SET FEATURES command that may affect this word . If the Streaming feature set is not supported by the device, then the content of word 97 shall be zero.

This word is valid if bit 4 of word 84 is set to one indicating that the Streaming feature set is supported.

7.18.7.52 Words 98..99: Streaming Performance Granularity

These words define the fixed unit of time that is used in IDENTIFY DEVICE data word 96, word 97 and word 104, SET FEATURES subcommand Set Maximum Host Interface Sector Times (see 7.50.12), and in the Command Completion Time Limit that is passed in streaming commands . The unit of time for this parameter shall be in microseconds (e.g., a value of 10 000 indicates 10 milliseconds) . If yy was returned by the ATA device as the Streaming Performance Granularity, then:

- a) the Command Completion Time Limit in the Feature field for a streaming command shall be yy microseconds;
- b) the Streaming Transfer Time shall be:
  - A) ((word 96) * (yy / 65 536)) microseconds; or
  - B) ((word 104) * (yy / 65 536)) microseconds;
- c) the Streaming Access Latency shall be ((word 97) * (yy / 256)) microseconds; and
- d) taking these units into account, the host may calculate the estimated time for a streaming command of size S logical sectors as:
  - A) for PIO ((word 104 * S / 65 536) + (word 97 / 256)) * yy microseconds; or
  - B) for DMA ((word 96 * S / 65 536) + (word 97 / 256)) * yy microseconds.

The value of the Streaming Performance Granularity is vendor specific and fixed for a device.

This word is valid if bit 4 of word 84 is set to one indicating that the Streaming feature set is supported.

7.18.7.53 Words 100..103: Total Number of User Addressable Logical Sectors for the 48-bit Address feature set

Words 100..103 contain a value that is one greater than the maximum LBA in the user data area when the 48-bit Addressing feature set is supported . The maximum value that shall be placed in this field is 0000_FFFF_FFFF_FFFFh . Support of these words is mandatory if the 48-bit Address feature set is supported.

7.18.7.54 Word 104: Streaming Transfer Time - PIO

Word 104 defines the Streaming Transfer Time for PIO mode . The worst-case sustainable transfer time per logical sector for the device is calculated as follows:

$$\text{Worst Case Sustainable Transfer Time} = \frac{x \times y}{65\ 536}$$

Where:

x = Streaming Performance Granularity (see 7.18.7.52); and
y = Streaming Transfer Time for PIO mode.

The content of word 104 may be affected by the host issuing a Set Maximum Host Interface Sector Times (see 7.50.12) . As a result, the host should issue an IDENTIFY DEVICE command after issuing a SET FEATURES command that may affect this word . If the Streaming feature set is not supported by the device, then the content of word 104 shall be zero.

This word is valid if bit 4 of word 84 is set to one indicating that the Streaming feature set is supported.

7.18.7.55 Word 105: Maximum number of 512-byte blocks of LBA Range Entries per DATA SET MANAGEMENT command

Word 105 contains the maximum number of 512-byte blocks of LBA Range Entries per DATA SET MANAGEMENT command that the ATA device shall accept . A value of 0000_0000h indicates that the maximum number of 512-byte blocks of LBA Range Entries is not specified.

If bit 0 of word 169 (see 7.18.7.71) is cleared to zero, then word 105 is reserved.

7.18.7.56 Word 106: Physical sector size / logical sector size

If bit 14 of word 106 is set to one and bit 15 of word 106 is cleared to zero, then the contents of word 106 contain valid information . Otherwise, information is not valid in this word.

If bit 13 of word 106 is set to one, then the device has more than one logical sector per physical sector and bits (3:0) of word 106 are valid . See 7.18.7.76 for information on the alignment of logical sectors within a physical sector.

If bit 12 of word 106 is set to one, then the device has been formatted with a logical sector size larger than 256 words and words 117..118 (see 7.18.7.61) are valid . If bit 12 of word 106 is cleared to zero, then words 117..118 are invalid and the logical sector size is 256 words .

Bits (11:4) of word 106 are reserved.

Bits (3:0) of word 106 indicate the size of the device physical sectors in power of two logical sectors.

Example:

> Bits (3:0): 0 = 2^0 = 1 logical sector per physical sector
> Bits (3:0): 1 = 2^1 = 2 logical sectors per physical sector
> Bits (3:0): 2 = 2^2 = 4 logical sectors per physical sector
> Bits (3:0): 3 = 2^3 = 8 logical sectors per physical sector

7.18.7.57 Word 107: Inter-seek delay for ISO 7779 standard acoustic testing

Word 107 is the manufacturer's recommended time delay between seeks in microseconds during ISO 7779 standard acoustic testing (i.e., ISO 7779 value t_D (see ISO 7779:1999 (E))).

7.18.7.58 Words 108..111: World wide name

Words 108..111 contain a mandatory World Wide Name (WWN) in the NAA IEEE Registered identifier format.

Word 108 bits (15:12) shall contain 5h . All other values are reserved.

Word 108 bits (11:0) and word 109 bits (15:4) shall contain the Organization Unique Identifier (OUI) (i.e., company ID) for the device manufacturer assigned by the IEEE.

The identifier may be obtained from:

> Institute of Electrical and Electronic Engineers, Inc.
> Registration Authority Committee
> 445 Hoes Lane
> Piscataway, NJ 08855-1331
> http://standards.ieee.org

Word 109 bits (3:0), word 110, and word 111 shall contain a value assigned by the vendor that is unique for the device in the OUI domain.

The IDENTIFY DEVICE data World Wide Name field is shown by word number in table 59.

Table 59 — IDENTIFY DEVICE data World Wide Name field (word-based view)

Word	Bit number within each word
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
108	NAA (5h)				bit 23 (MSB)		IEEE OUI									bit 12
109	bit 11											(LSB) bit 0	bit 35 (MSB)			bit 32
110	bit 31						Unique ID									bit 16
111	bit 15															(LSB) bit 0

The World Wide Name field is shown by byte number in table 60.

Table 60 — IDENTIFY DEVICE data World Wide Name field (byte-based view)

Word	Offset	Bit number within each byte							
		7	6	5	4	3	2	1	0
108	216	bit 19		IEEE OUI					bit 12
	217		NAA (5h)			bit 23 (MSB)			bit 20
109	218	bit 3			(LSB) bit 0	bit 35 (MSB)		Unique ID	bit 32
	219	bit 11			IEEE OUI				bit 4
110	220	bit 23							bit 16
	221	bit 31			Unique ID				bit 24
111	222	bit 7							(LSB) bit 0
	223	bit 15							bit 8

7.18.7.59 Words 112..115: Reserved for a 128-bit world wide name

7.18.7.60 Word 116: Reserved for TLC

7.18.7.61 Words 117..118: Logical sector size

Words 117..118 indicate the size of device logical sectors in words . The value of logical sector size shall be equal to or greater than 256 . The value of logical sector size shall be valid when bit 12 of word 106 is set to one . All logical sectors on a device shall be this length . When bit 12 of word 106 is cleared to zero words 117..118 shall be cleared to zero.

7.18.7.62 Word 119: See 7.18.7.40

7.18.7.63 Word 120: See 7.18.7.41

7.18.7.64 Words 121..126: Reserved for expanded supported and enabled settings

7.18.7.65 Word 127: Obsolete

7.18.7.66 Word 128: Security status

Support of this word is mandatory if the Security feature set is supported . If the Security feature set is not supported, this word shall be cleared to zero.

Bit 8 of word 128 indicates the Master Password Capability . If security is enabled and the Master Password Capability is high, bit 8 shall be cleared to zero . If security is enabled and the Master Password Capability is maximum, bit 8 shall be set to one . When security is disabled, bit 8 shall be cleared to zero.

Bit 5 of word 128 set to one indicates that the enhanced mode of the SECURITY ERASE UNIT command is supported.

Bit 4 of word 128 (i.e., Password Attempt Counter Exceeded bit) set to one indicates that the password attempt counter has decremented to zero.

Bit 3 of word 128 set to one indicates that security is frozen.

Bit 2 of word 128 set to one indicates that security is locked.

Bit 1 of word 128 set to one indicates that security is enabled . This is a copy of word 85, bit 1.

Bit 0 of word 128 set to one indicates that the Security feature set is supported . This is a copy of word 82, bit 1.

7.18.7.67 Words 129..159: Vendor specific

7.18.7.68 Word 160: CFA power mode

Word 160 indicates the presence and status of a CFA feature set device that supports CFA Power Mode 1 . Support of this word is mandatory if CFA Power Mode 1 is supported .

If bit 13 of word 160 is set to one, then the device is in CFA Power Mode 1 to perform one or more commands implemented by the device .

If bit 12 of word 160 is set to one, then the device is in CFA Power Mode 0 (see 7.50.9).

Bits (11:0) indicate the maximum average RMS current in Milliamperes required during 3.3V or 5V device operation in CFA Power Mode 1 .

7.18.7.69 Words 161..167: Reserved for assignment by the CompactFlash Association

7.18.7.70 Word 168: Device Nominal Form Factor

Bits (3:0) of Word 168 indicate the nominal form factor of the device and is defined in table 61.

Table 61 — Device Nominal Form Factor

Value	Description
0h	Nominal form factor not reported
1h	5.25 inch nominal form factor
2h	3.5 inch nominal form factor
3h	2.5 inch nominal form factor
4h	1.8 inch nominal form factor
5h	Less than 1.8 inch nominal form factor
6h-Fh	Reserved

7.18.7.71 Word 169: DATA SET MANAGEMENT is supported

Word 169 bits 15:1 are reserved.

If bit 0 of word 169 is set to one, then the device supports the Trim bit of the DATA SET MANAGEMENT command . See 7.18.7.30 and 7.10.3.2 for reporting Trim methods.

If bit 0 of word 169 is cleared to zero, then the Trim bit in the DATA SET MANAGEMENT command is not supported and:

   a) word 105 is reserved;
   b) bit 5 of word 69 is reserved; and
   c) bit 14 of word 69 is reserved.

7.18.7.72 Words 170..173: Additional Product Identifier

This field contains the Additional Product Identifier . The contents of this field is an ATA string of eight bytes in the format defined by 3.3.10 . The device shall pad the string with spaces (i.e., 20h), if necessary, to ensure that the string is the proper length . If the Additional Product Identifier is not present, then this field is reserved.

7.18.7.73 Words 174..175: Reserved

7.18.7.74 Words 176..205: Current media serial number

Words 176..205 contain the current media serial number . Media serial numbers shall be an ATA string of 60 bytes in the format defined by 3.3.10 . The first 40 bytes shall indicate the media serial number and the remaining 20 bytes shall indicate the media manufacturer.

7.18.7.75 Word 206: SCT Command Transport

Bits (15:12) indicate support for vendor specific action codes.

Bits (11:6) of word 206 are reserved.

If bit 5 of word 206 is set to one, then the device supports SCT Data Tables (see 8.3.5).

If bit 4 of word 206 is set to one, then the device supports SCT Feature Control (see 8.3.4).

If bit 3 of word 206 is set to one, then the device supports SCT Error Recovery Control (see 8.3.3).

If bit 2 of word 206 is set to one, then the device supports SCT Write Same (see 8.3.2).

Bit 1 of word 206 is obsolete.

If bit 0 of word 206 is set to one, then the device supports the SCT Command Transport including SCT Read Status (see clause 8).

7.18.7.76 Word 209: Alignment of logical blocks within a physical block

Word 209 shall report the location of logical sector zero within the first physical sector of the media . See Annex E for more information . This word is valid if bit 13 of word 106 is set to one.

Bit 15 of word 209 shall be cleared to zero.

Bit 14 of word 209 shall be set to one.

Bits 13:0 of word 209 indicate the Logical sector offset within the first physical sector where the first logical sector is placed.

7.18.7.77 Words 210..211: Write-Read-Verify Sector Count Mode 3

Words 210..211 shall indicate the number of logical sectors to be verified after every spin-up, when Write-Read-Verify feature set mode 3 is selected (i.e., word 220 bits 7:0 are 03h) . This field is valid when word 120 bit 1 is set to one and word 220 bits 7:0 are 03h.

7.18.7.78 Words 212..213: Write-Read-Verify Sector Count Mode 2

Words 212..213 shall indicate the number of logical sectors to be verified after every spin-up, when Write-Read-Verify feature set mode 2 is selected (i.e., word 220 bits 7:0 are 02h) . These words are valid when word 119 bit 1 is set to one.

7.18.7.79 Word 214: NV Cache Capabilities

Both the NV Cache Power Mode feature set version (word 214 bits (11:8)) and the NV Cache feature set version (word 214 bits (15:12)) shall be set to zero.

If bit 4 of word 214 is set to one, the NV Cache feature set is enabled.

If bit 1 of word 214 is set to one, the NV Cache Power Management feature is enabled . This capability is enabled by issuing a SET NV CACHE POWER MODE command and disabled by issuing a RETURN FROM NV CACHE POWER MODE command.

If bit 0 of word 214 is set to one, the NV Cache Power Management feature set is supported.

7.18.7.80 Words 215..216: NV Cache Size in Logical Blocks

Words 215..216 indicate the maximum number of logical sectors that the device's NV Cache Set contains for the host to pin (see 4.19.2) . This field is valid if word 214 bit 0 or bit 4 is set to one indicating NV Cache feature set is supported.

7.18.7.81 Word 217: Nominal media rotation rate

Word 217 indicates the nominal media rotation rate of the device and is defined in table 62.

Table 62 — Nominal Media Rotation Rate

Value	Description
0000h	Rate not reported
0001h	Non-rotating media (e.g., solid state device)
0002h-0400h	Reserved
0401h-FFFEh	Nominal media rotation rate in rotations per minute (rpm) (e.g., 7 200 rpm = 1C20h)
FFFFh	Reserved

7.18.7.82 Word 218: Reserved

7.18.7.83 Word 219: NV Cache Options

Word 219 bits (7:0) contains the device's estimate of the amount of time in seconds it takes for the device to satisfy a read or write request from its rotational media when the read or write request is received while the rotational media is not spinning . This field is valid if bit 4 of word 214 is set to one.

7.18.7.84 Word 220

Word 220 contains the current mode of the Write-Read-Verify feature set, as set by the SET FEATURES Enable/Disable Write-Read-Verify subcommand . See 7.50.10 for more information on setting Write-Read-Verify mode.

Bits (15:8) of word 220 are reserved.

Bits (7:0) of word 220 indicate the current mode of the Write-Read-Verify feature set.

7.18.7.85 Word 221: Reserved

7.18.7.86 Word 222: Transport major version number

If word 222 is not set to FFFFh or 0000h, then the device claims compliance with one or more of the ATA transport standard major versions as indicated by bits (11:0) . Values other than 0000h and FFFFh are bit significant . A device may set more than one bit to one.

7.18.7.87 Word 223: Transport minor version number

Table 63 defines the value that shall be reported in word 223 to indicate the version of the standard that guided the implementation.

Table 63 — Transport minor version number

Value	Minor Version
0000h	Minor version not reported
0001h-0020h	Reserved
0021h	ATA8-AST T13 Project D1697 Version 0b
0022h-0050h	Reserved
0051h	ATA-AST T13 Project D1697 Version 1
0052h-FFFEh	Reserved
FFFFh	Minor version not reported

7.18.7.88 Words 224..229: Reserved

7.18.7.89 Words 230..233: Extended Number of User Addressable Sectors

If word 69 bit 4 (see 7.18.7.30) is set to one, then words 230..233 contain a value that is one greater than the maximum LBA in user accessible space . The maximum value that shall be placed in this field is 0000_FFFF_FFFF_FFFFh.

7.18.7.90 Word 234: Minimum number of 512-byte data blocks per DOWNLOAD MICROCODE command mode 03h

Word 234 contains the minimum number of 512-byte data blocks per DOWNLOAD MICROCODE command that the ATA device accepts when using the offset transfer method (see 7.13) . This word is valid if bit 0 of word 83, bit 0 of word 86, and bit 4 of word 120 are set to one (i.e., the DOWNLOAD MICROCODE command using the offset transfer method is supported) . The values 0000h and FFFFh indicate no minimum is specified (i.e., that there is no minimum number of 512-byte data blocks).

7.18.7.91 Word 235: Maximum number of 512-byte data blocks per DOWNLOAD MICROCODE command mode 03h

Word 234 contains the maximum number of 512-byte data blocks per DOWNLOAD MICROCODE command that the ATA device shall accept when using the offset transfer method (see 7.13) . This word is valid if bit 0 of word 83, bit 0 of word 86, and bit 4 of word 120 are set to one (i.e., the DOWNLOAD MICROCODE command using the offset transfer method is supported) . The values 0000h and FFFFh indicate no maximum is specified (i.e., that there is no maximum number of 512-byte data blocks)

7.18.7.92 Words 236..254: Reserved

7.18.7.93 Word 255: Integrity word

If bits (7:0) of this word contain the Checksum Validity Indicator A5h, then bits (15:8) contain the data structure checksum . The data structure checksum is the two's complement of the sum of all bytes in words 0..254 and the byte consisting of bits (7:0) in word 255 . Each byte shall be added with unsigned arithmetic, and overflow shall be ignored . The sum of all 512 bytes is zero when the checksum is correct.

7.19 IDENTIFY PACKET DEVICE - A1h, PIO Data-In

7.19.1 Feature Set

This 28-bit command is mandatory for devices implementing the PACKET feature set (see 4.3).

7.19.2 Description

The IDENTIFY PACKET DEVICE command enables the host to receive parameter information from a device that implements the PACKET feature set . See table 65 for a description of the return data.

Devices may read the non-volatile media in order to complete this command.

The IDENTIFY PACKET DEVICE data contains information regarding feature or command support . If the host issues a command that is indicated as not supported in the IDENTIFY PACKET DEVICE data, the device shall return command aborted for the command.

7.19.3 Inputs

See table 64 for the IDENTIFY PACKET DEVICE command inputs.

Table 64 — IDENTIFY PACKET DEVICE command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 A1h

7.19.4 Normal Outputs

See table 215.

7.19.5 Error Outputs

The device shall return command aborted if the device does not implement this command, otherwise, the device shall not report an error . See table 240 . The device may return command completion with the Error bit set to one if an Interface CRC error has occurred.

> NOTE 14 — There is no defined mechanism for a device to return an Interface CRC error status that may have occurred during the last data block of a PIO-in data transfer . There may be other mechanisms in which a host may verify that an Interface CRC error occurred in these cases.

7.19.6 Input From the Device to the Host Data Structure

7.19.6.1 Overview

Table 65 specifies the format of IDENTIFY PACKET DEVICE data.

Table 65 — IDENTIFY PACKET DEVICE data (part 1 of 13)

Word	O M	S P	F V	Description
0	M	B		General configuration
			F	15:14 10b = ATAPI device
			F	11b = Reserved
				13 Reserved
			F	12:8 Indicates command set used by the device
			X	7 Obsolete
			F	6:5 00b = Device shall set DRQ to one within 3 ms of receiving PACKET command.
				01b = Obsolete.
				10b = Device shall set DRQ to one within 50 μs of receiving PACKET command.
				11b = Reserved
				4:3 Reserved
			V	2 Incomplete response
			F	1:0 00b = 12 byte command packet
				01b = 16 byte command packet
				1xb = Reserved
1				Reserved
2		B	V	Specific configuration
3..9				Reserved
10..19	M	B	F	Serial number (ATA String)
20..22				Reserved
23..26	M	B	F	Firmware revision (ATA String)
27..46	M	B	F	Model number (ATA String)
47..48				Reserved

Key:
F/V – Fixed/variable content
    F – The content of the field is fixed and does not change . The DCO command may change the value of a fixed field.
    V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
    X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
    M – Support of the word is mandatory.
    O – Support of the word is optional.
S/P – Content applies to Serial or Parallel transport
    S – Serial Transport
    P – Parallel Transport
    B – Both Serial and Parallel Transports
    N – Belongs to a transport other than Serial or Parallel

Table 65 — IDENTIFY PACKET DEVICE data (part 2 of 13)

Word	O M	S P	F V	Description
49	M			Capabilities
			X	15:12 Obsolete
		P	F	11 1 = IORDY supported
		P	F	10 1 = IORDY may be disabled
			F	9 Shall be set to one.
		P	F	8 1 = DMA supported . Devices that require the DMADIR bit in the PACKET command shall clear this bit to 0
			X	7:0 Vendor specific
50	O			Capabilities
			F	15 Shall be cleared to zero.
			F	14 Shall be set to one.
				13:2 Reserved
			X	1 Obsolete
		B	F	0 Shall be set to one to indicate a device specific Standby timer value minimum.
51..52			X	Obsolete
53	M			15:3 Reserved
		B	F	2 1 = the fields reported in word 88 are valid
		B	F	1 1 = the fields reported in words 64..70 are valid
			X	0 Obsolete
54..61				Reserved

Key:	

F/V – Fixed/variable content
    F – The content of the field is fixed and does not change . The DCO command may change the value of a fixed field.
    V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
    X – The fixed or variable type of this field is not defined in this standard.
	O/M – Mandatory/optional requirement.
	    M – Support of the word is mandatory.
	    O – Support of the word is optional.
	S/P – Content applies to Serial or Parallel transport
	    S – Serial Transport
	    P – Parallel Transport
	    B – Both Serial and Parallel Transports
	    N – Belongs to a transport other than Serial or Parallel

Table 65 — IDENTIFY PACKET DEVICE data (part 3 of 13)

Word	O M	S P	F V	Description
62	M			DMADIR (see 7.19.6.17)
		S	F	15 1 = DMADIR bit in the PACKET command is required for DMA transfers 0 = DMADIR bit in PACKET command is not required for DMA transfers.
				14:11 Reserved
		P	F	10 1 = DMA is supported
		P	F	9 1 = Multiword DMA mode 2 is supported
		P	F	8 1 = Multiword DMA mode 1 is supported
		P	F	7 1 = Multiword DMA mode 0 is supported
		P	F	6 1 = Ultra DMA mode 6 and below are supported
		P	F	5 1 = Ultra DMA mode 5 and below are supported
		P	F	4 1 = Ultra DMA mode 4 and below are supported
		P	F	3 1 = Ultra DMA mode 3 and below are supported
		P	F	2 1 = Ultra DMA mode 2 and below are supported
		P	F	1 1 = Ultra DMA mode 1 and below are supported
		P	F	0 1 = Ultra DMA mode 0 is supported
63	M			15:11 Reserved
		P	V	10 1 = Multiword DMA mode 2 is selected
		P	V	9 1 = Multiword DMA mode 1 is selected
		P	V	8 1 = Multiword DMA mode 0 is selected
				7:3 Reserved
		P	F	2 1 = Multiword DMA mode 2 and below are supported.
		P	F	1 1 = Multiword DMA mode 1 and below are supported.
		P	F	0 1 = Multiword DMA mode 0 is supported Multiword DMA mode selected.
64	M			15:8 Reserved
		P	F	7:0 PIO transfer modes supported
65	M			Minimum Multiword DMA transfer cycle time per word
		P	F	15:0 Cycle time in nanoseconds
66	M			Manufacturer's recommended Multiword DMA transfer cycle time
		P	F	15:0 Cycle time in nanoseconds
67	M			Minimum PIO transfer cycle time without flow control
		P	F	15:0 Cycle time in nanoseconds

Key:
F/V – Fixed/variable content
       F – The content of the field is fixed and does not change . The DCO command may change the value of a fixed field.
       V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
       X – The fixed or variable type of this field is not defined in this standard.
O/M – Mandatory/optional requirement.
       M – Support of the word is mandatory.
       O – Support of the word is optional.
S/P – Content applies to Serial or Parallel transport
       S – Serial Transport
       P – Parallel Transport
       B – Both Serial and Parallel Transports
       N – Belongs to a transport other than Serial or Parallel

Table 65 — IDENTIFY PACKET DEVICE data (part 4 of 13)

Word	O M	S P	F V	Description
68	M			Minimum PIO transfer cycle time with IORDY (see ATA8-APT) flow control
		P	F	15:0 Cycle time in nanoseconds
69..70				Reserved
71..72			X	Obsolete
73..74				Reserved
75			X	Obsolete
76	O	S		Serial ATA Capabilities
				15:11 Reserved for Serial ATA
			F	10 1 = The SATA Phy Event Counters log is supported
			F	9 1 = Receipt of host initiated power management requests are supported
			F	8 1 = The NCQ feature set is supported
				7:3 Reserved for future Serial ATA
			F	2 1 = The SATA Gen2 Signaling Speed (3.0Gb/s) is supported
			F	1 1 = The SATA Gen1 Signaling Speed (1.5Gb/s) is supported
			F	0 Shall be cleared to zero
77				Reserved for Serial ATA
78	O	S		Serial ATA features supported
				15:7 Reserved for Serial ATA
			F	6 1 = The SSP feature set is supported
				5 Reserved for Serial ATA
			F	4 1 = In-order data delivery is supported
			F	3 1 = Device initiated power management is supported
			F	2 1 = DMA Setup auto-activation is supported
			F	1 1 = non-zero buffer offsets is supported
			F	0 Shall be cleared to zero

Key:
F/V – Fixed/variable content
    F – The content of the field is fixed and does not change . The DCO command may change the value of a fixed field.
    V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
    X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
    M – Support of the word is mandatory.
    O – Support of the word is optional.
S/P – Content applies to Serial or Parallel transport
    S – Serial Transport
    P – Parallel Transport
    B – Both Serial and Parallel Transports
    N – Belongs to a transport other than Serial or Parallel

Table 65 — IDENTIFY PACKET DEVICE data (part 5 of 13)

Word	O M	S P	F V	Description
79	O	S		Serial ATA features enabled
				15:7 Reserved for Serial ATA
			V	6 1 = The SSP feature set is enabled
				5 Reserved for Serial ATA
			V	4 1 = In-order data delivery is enabled
			V	3 1 = Device initiated power management is enabled
			V	2 1 = DMA Setup auto-activation is enabled
			V	1 1 = Non-zero buffer offsets is enabled
			F	0 Shall be cleared to zero
80	M	B		Major version number
				0000h or FFFFh = device does not report version
				15:9 Reserved
			F	8 1 = ATA8-ACS is supported
			F	7 1 = ATA/ATAPI-7 is supported
			F	6 1 = ATA/ATAPI-6 is supported
			F	5 1 = ATA/ATAPI-5 is supported
			F	4 1 = ATA/ATAPI-4 is supported
			X	3 Obsolete
			X	2 Obsolete
			X	1 Obsolete
				0 Reserved
81	M	B	F	Minor version number

Key:
F/V – Fixed/variable content
   F – The content of the field is fixed and does not change . The DCO command may change the value of a fixed field.
   V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
   X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
   M – Support of the word is mandatory.
   O – Support of the word is optional.
S/P – Content applies to Serial or Parallel transport
   S – Serial Transport
   P – Parallel Transport
   B – Both Serial and Parallel Transports
   N – Belongs to a transport other than Serial or Parallel

Table 65 — IDENTIFY PACKET DEVICE data (part 6 of 13)

Word	O M	S P	F V	Description
82	M	B		Commands and feature sets supported
			X	15 Obsolete
			F	14 Shall be set to one to indicate that the NOP command is supported
			F	13 Shall be cleared to zero to indicate that the READ BUFFER command is not supported
			F	12 Shall be cleared to zero to indicate that the WRITE BUFFER command is not supported
			X	11 Obsolete
			F	10 Shall be cleared to zero to indicate that the HPA set is not supported
			F	9 Shall be set to one to indicate that the DEVICE RESET command is supported
			X	8 Obsolete
			X	7 Obsolete
			F	6 1 = Read look-ahead supported
			F	5 1 = The volatile write cache is supported
			F	4 Shall be set to one indicating the PACKET feature set is supported.
			F	3 1 = The Power Management feature set supported
			X	2 Obsolete
			F	1 1 = The Security feature set is supported
			F	0 Shall be cleared to zero to indicate that the SMART feature set is not supported

Key:
F/V – Fixed/variable content
    F – The content of the field is fixed and does not change . The DCO command may change the value of a fixed field.
    V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
    X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
    M – Support of the word is mandatory.
    O – Support of the word is optional.
S/P – Content applies to Serial or Parallel transport
    S – Serial Transport
    P – Parallel Transport
    B – Both Serial and Parallel Transports
    N – Belongs to a transport other than Serial or Parallel

Table 65 — IDENTIFY PACKET DEVICE data (part 7 of 13)

Word	O M	S P	F V	Description
83	M	B		Commands and feature sets supported
			F	15 Shall be cleared to zero
			F	14 Shall be set to one
				13 Reserved
			F	12 1 = The FLUSH CACHE command is supported
			F	11 1 = The DCO feature set is supported
				10 Reserved
			F	9 1 = The AAM feature set is supported
			F	8 1 = The SET MAX security extension is supported
				7 Reserved for Address Offset Reserved Area Boot Method
			F	6 1 = The SET FEATURES subcommand is required to spin-up after power-up
			F	5 1 = The PUIS feature set is supported
			X	4 Obsolete
			F	3 1 = The APM feature set is supported
				2:1 Reserved
			F	0 Shall be cleared to zero to indicate that the DOWNLOAD MICROCODE command is not supported
84	M	B		Commands and feature sets supported
			F	15 Shall be cleared to zero
			F	14 Shall be set to one
				13:9 Reserved
			F	8 shall be set to one to indicate that the mandator WWN is supported
				7:6 Reserved
			F	5 1 = The GPL feature set is supported
				4:0 Reserved

Key:
F/V – Fixed/variable content
    F – The content of the field is fixed and does not change . The DCO command may change the value of a fixed field.
    V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
    X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
    M – Support of the word is mandatory.
    O – Support of the word is optional.
S/P – Content applies to Serial or Parallel transport
    S – Serial Transport
    P – Parallel Transport
    B – Both Serial and Parallel Transports
    N – Belongs to a transport other than Serial or Parallel

Table 65 — IDENTIFY PACKET DEVICE data (part 8 of 13)

Word	O M	S P	F V	Description
85	M	B		Commands and feature sets supported or enabled
			X	15 Obsolete
			F	14 Shall be set to one to indicate that the NOP command is supported
			F	13 Shall be cleared to zero to indicate that the READ BUFFER command is not supported
			F	12 Shall be cleared to zero to indicate that the WRITE BUFFER command is not supported
			X	11 Obsolete
			V	10 Shall be cleared to zero to indicate that the HPA feature set is not supported
			F	9 Shall be set to one to indicate that the DEVICE RESET command is supported
			X	8 Obsolete
			X	7 Obsolete
			V	6 1 = Read look-ahead is enabled
			V	5 1 = The volatile write cache is enabled
			F	4 Shall be set to one indicating the PACKET feature set is supported.
			F	3 1 = Power Management feature set is enabled
			X	2 Obsolete
			V	1 1 = The Security feature set is enabled
			F	0 Shall be cleared to zero to indicate that the SMART feature set is not supported

Key:
F/V – Fixed/variable content
    F – The content of the field is fixed and does not change . The DCO command may change the value of a fixed field.
    V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
    X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
    M – Support of the word is mandatory.
    O – Support of the word is optional.
S/P – Content applies to Serial or Parallel transport
    S – Serial Transport
    P – Parallel Transport
    B – Both Serial and Parallel Transports
    N – Belongs to a transport other than Serial or Parallel

Table 65 — IDENTIFY PACKET DEVICE data (part 9 of 13)

Word	O M	S P	F V	Description
86	M	B		Commands and feature sets supported or enabled
				15:13 Reserved
			V	12 1 = The FLUSH CACHE command is supported
			F	11 1 = The DCO feature set is supported
				10 Reserved
			V	9 1 = The AAM feature set enabled
			V	8 1 = SET MAX security extension enabled by a SET MAX SET PASSWORD
				7 Reserved for Address Offset Reserved Area Boot Method
			F	6 1 = SET FEATURES subcommand required to spin-up after power-up
			V	5 1 = The PUIS feature set is enabled
			X	4 Obsolete
			V	3 1 = The APM feature set is enabled
				2:1 Reserved
			F	0 Shall be cleared to zero to indicate that the DOWNLOAD MICROCODE command is not supported
87	M			Commands and feature sets supported or enabled
			F	15 Shall be cleared to zero
			F	14 Shall be set to one
				13:9 Reserved
			F	8 Shall be set to one to indicate that the mandator WWN is supported
				7:6 Reserved
			F	5 This bit is a copy of word 84 bit 5
				4:0 Reserved

Key:
F/V – Fixed/variable content
    F – The content of the field is fixed and does not change . The DCO command may change the value of a fixed field.
    V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
    X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
    M – Support of the word is mandatory.
    O – Support of the word is optional.
S/P – Content applies to Serial or Parallel transport
    S – Serial Transport
    P – Parallel Transport
    B – Both Serial and Parallel Transports
    N – Belongs to a transport other than Serial or Parallel

Table 65 — IDENTIFY PACKET DEVICE data (part 10 of 13)

Word	O M	S P	F V	Description
88	M	B		Ultra DMA modes
				15 Reserved
			V	14 1 = Ultra DMA mode 6 is selected
			V	13 1 = Ultra DMA mode 5 is selected
			V	12 1 = Ultra DMA mode 4 is selected
			V	11 1 = Ultra DMA mode 3 is selected
			V	10 1 = Ultra DMA mode 2 is selected
			V	9 1 = Ultra DMA mode 1 is selected
			V	8 1 = Ultra DMA mode 0 is selected
				7 Reserved
			F	6 1 = Ultra DMA mode 6 and below are supported.
			F	5 1 = Ultra DMA mode 5 and below are supported.
			F	4 1 = Ultra DMA mode 4 and below are supported.
			F	3 1 = Ultra DMA mode 3 and below are supported.
			F	2 1 = Ultra DMA mode 2 and below are supported.
			F	1 1 = Ultra DMA mode 1 and below are supported.
			F	0 1 = Ultra DMA mode 0 is supported.
89	O	B	F	Time required for Normal Erase mode SECURITY ERASE UNIT command
90	O	B	F	Time required for an Enhanced Erase mode SECURITY ERASE UNIT command
91	O	B	V	Current APM level value (see 7.19.6.39)
92	O	B	V	Master Password Identifier
93	M	B		Hardware reset result. The contents of bits (12:0) of this word shall change only during the execution of a hardware reset.
			F	15 Shall be cleared to zero.
			F	14 Shall be set to one.
			V	13 1 = device detected CBLID- (see ATA8-APT) above V_{iH}
				0 = device detected CBLID- (see ATA8-APT) below V_{iL}
				12:8 Device 1 hardware reset result . Device 0 shall clear these bits to zero . Device 1 shall set these bits as follows:
				12 Reserved.
			V	11 0 = Device 1 did not assert PDIAG-.

Key:
F/V – Fixed/variable content
    F – The content of the field is fixed and does not change . The DCO command may change the value of a fixed field.
    V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
    X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
    M – Support of the word is mandatory.
    O – Support of the word is optional.
S/P – Content applies to Serial or Parallel transport
    S – Serial Transport
    P – Parallel Transport
    B – Both Serial and Parallel Transports
    N – Belongs to a transport other than Serial or Parallel

Table 65 — IDENTIFY PACKET DEVICE data (part 11 of 13)

Word	O M	S P	F V	Description
				1 = Device 1 asserted PDIAG-.
			V	10:9 These bits indicate how Device 1 determined the device number:
				00b = Reserved.
				01b = a jumper was used.
				10b = the CSEL signal was used.
				11b = some other method was used or the method is unknown.
			F	8 Shall be set to one.
				7:0 Device 0 hardware reset result . Device 1 shall clear these bits to zero . Device 0 shall set these bits as follows:
				7 Reserved.
			F	6 0 = Device 0 does not respond when Device 1 is selected.
				1 = Device 0 responds when Device 1 is selected.
			V	5 0 = Device 0 did not detect the assertion of DASP-.
				1 = Device 0 detected the assertion of DASP-.
			V	4 0 = Device 0 did not detect the assertion of PDIAG-.
				1 = Device 0 detected the assertion of PDIAG-.
			V	3 0 = Device 0 failed diagnostics.
				1 = Device 0 passed diagnostics.
			V	2:1 These bits indicate how Device 0 determined the device number:
				00b = Reserved.
				01b = a jumper was used.
				10b = the CSEL signal was used.
				11b = some other method was used or the method is unknown.
			F	0 Shall be set to one.
94	O			Current automatic acoustic management value
		B	F	15:8 Vendor's recommended acoustic management value.
		B	V	7:0 Current automatic acoustic management value.
95..107				Reserved
108..111	M	B	F	World wide name
112..115				Reserved for world wide name extension to 128 bits
116..118				Reserved

Key:
F/V – Fixed/variable content
    F – The content of the field is fixed and does not change . The DCO command may change the value of a fixed field.
    V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
    X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
    M – Support of the word is mandatory.
    O – Support of the word is optional.
S/P – Content applies to Serial or Parallel transport
    S – Serial Transport
    P – Parallel Transport
    B – Both Serial and Parallel Transports
    N – Belongs to a transport other than Serial or Parallel

Table 65 — IDENTIFY PACKET DEVICE data (part 12 of 13)

Word	O M	S P	F V	Description
119				Commands and feature sets supported 15:0 Reserved
120				Commands and feature sets supported or enabled 15:0 Reserved
121..125				Reserved
125	M	B	F	ATAPI byte count = 0 behavior
126..127			X	Obsolete
128	O			Security status 15:9 Reserved 8 Master Password Capability: 0 = High, 1 = Maximum 7:6 Reserved 5 1 = The enhanced security erase mode is supported 4 1 = The Security count is expired 3 1 = Security is frozen 2 1 = Security is locked 1 1 = Security is enabled 0 1 = Security is supported
129..159			X	Vendor specific

Note: For word 128, the F/V column entries are: V (bit 8), F (bit 5), V (bit 4), V (bit 3), V (bit 2), V (bit 1), F (bit 0).

Key:
F/V – Fixed/variable content
   F – The content of the field is fixed and does not change . The DCO command may change the value of a fixed field.
   V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
   X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
   M – Support of the word is mandatory.
   O – Support of the word is optional.
S/P – Content applies to Serial or Parallel transport
   S – Serial Transport
   P – Parallel Transport
   B – Both Serial and Parallel Transports
   N – Belongs to a transport other than Serial or Parallel

Table 65 — IDENTIFY PACKET DEVICE data (part 13 of 13)

Word	O M	S P	F V	Description
160..175		N		Reserved for assignment by the CompactFlash Association
176..221				Reserved
222	M	B		Transport Major version number . 0000h or FFFFh = device does not report version
			F	15:12 Transport Type
				0h = Parallel
				1h = Serial
				2h-Fh = Reserved
				Parallel **Serial**
				11:5 Reserved Reserved
			F	4 Reserved SATA Rev 2.6
			F	3 Reserved SATA Rev 2.5
			F	2 Reserved SATA II: Extensions
			F	1 ATA/ATAPI-7 SATA 1.0a
			F	0 ATA8-APT ATA8-AST
223	M	B	F	Transport Minor version number
224..254				Reserved
255	O		V	Integrity word
		B		15:8 Checksum
		B		7:0 Checksum Validity Indicator

Key:	O/M – Mandatory/optional requirement.
F/V – Fixed/variable content	M – Support of the word is mandatory.
F – The content of the field is fixed and does not change . The DCO command may change the value of a fixed field.	O – Support of the word is optional.
	S/P – Content applies to Serial or Parallel transport
V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.	S – Serial Transport
	P – Parallel Transport
	B – Both Serial and Parallel Transports
X – The fixed or variable type of this field is not defined in this standard.	N – Belongs to a transport other than Serial or Parallel

7.19.6.2 Word 0: General configuration

Bits (15:14) of word 0 indicate the type of device . Bit 15 shall be set to one and bit 14 shall be cleared to zero to indicate the device is an ATAPI device .

Bits (12:8) of word 0 indicate the command set used by the device . This value follows the peripheral device type as defined in SPC-4 (e.g., 05h indicates a CD/DVD device).

Bit 7 of word 0 is Obsolete.

For PATA devices, bits (6:5) of word 0 indicate the DRQ response time when a PACKET command is received . A value of 00b indicates that the maximum time for a device to set DRQ to one after receiving a PACKET command is 3 ms . The value 01b is obsolete . A value of 10b indicates that the maximum time for a device to set DRQ to one after receiving a PACKET command is 50 μs . The value 11b is reserved.

If bit 2 of word 0 is set to one, then the content of the IDENTIFY PACKET DEVICE data is incomplete . This may occur if the device supports the PUIS feature set and required data is contained on the device media . The content of IDENTIFY DEVICE data word 0 and word 2 shall be valid.

Bits (1:0) of word 0 indicate the packet size the device supports . A value of 00b indicates that a 12-byte packet is supported and a value of 01b indicates a 16 byte packet . The values 10b and 11b are reserved.

7.19.6.3 Word 1: Reserved

7.19.6.4 Word 2: Specific configuration

Word 2 shall have the same content described for IDENTIFY DEVICE data word 2 (see 7.18.7.4).

7.19.6.5 Words 3..9: Reserved

7.19.6.6 Words 10..19: Serial number

If the ATAPI device does not report the serial number, then the content shall be 0000h in each word . Otherwise, the content shall be as described for IDENTIFY DEVICE data words 10..19 (see 7.18.7).

7.19.6.7 Words 20..22: Reserved

7.19.6.8 Words 23..26: Firmware revision

Words 23..26 shall have the content described for IDENTIFY DEVICE data words 23..26 (see 7.18.7.13).

7.19.6.9 Words 27..46: Model number

Words 27..46 shall have the content described for IDENTIFY DEVICE data words 27..46 (see 7.18.7.14).

7.19.6.10 Words 47..48: Reserved

7.19.6.11 Word 49: Capabilities

Bits (15:12) of word 49 are obsolete.

Bit 11 of word 49 indicates whether a device supports IORDY (see ATA8-APT) . If this bit is set to one, then the device supports IORDY (see ATA8-APT) operation . If this bit is cleared to zero, the device may support IORDY (see ATA8-APT) . If a device supports PIO mode 3 or higher, then this bit shall be set to one . For SATA devices, this bit shall be set to one.

Bit 10 of word 49 indicates a device's ability to enable or disable the use of IORDY (see ATA8-APT) . If this bit is set to one, then the device supports the disabling of IORDY (see ATA8-APT) . Disabling and enabling of IORDY (see ATA8-APT) is accomplished using the SET FEATURES command . For SATA devices, this bit shall be set to one.

Bit 9 of word 49 shall be set to one.

Bit 8 of word 49 indicates that DMA is supported . Devices that require the DMADIR bit in the PACKET command shall clear this bit to 0

7.19.6.12 Word 50: Capabilities

Word 50 shall have the content described for IDENTIFY DEVICE data word 50 (see 7.18.7.17) . Support of this word is mandatory if the STANDBY command is supported.

7.19.6.13 Word 51: Obsolete

7.19.6.14 Word 52: Obsolete

7.19.6.15 Word 53

Word 53 bits (2:0) shall have the content described for IDENTIFY DEVICE data word 53 bits (2:0) . Bits (15:3) are reserved.

7.19.6.16 Words 54..61: Reserved

7.19.6.17 Word 62: DMADIR

ATAPI devices may require use of the DMADIR bit to indicate transfer direction for PACKET commands using the DMA data transfer protocol . Word 62 indicates if such support is required.

If word 62 bit 15 is set to one, then the DMADIR bit in the PACKET command is required by the device for PACKET commands using the DMA data transfer protocol and:

a) word 63 bits (2:0);
b) word 49 bit 15;
c) word 49 bit 8; and
d) word 88 bits (6:0),

shall be cleared to zero.

If word 62 bit 15 is cleared to zero, then:

a) the DMADIR bit in the PACKET command is not required; and
b) word 62 shall be cleared to zero.

Bits (14:11) of word 62 are reserved.

If word 62 bit 15 is set to one and word 62 bit:

a) 10 is set to one, then DMA is supported;
b) 10 is cleared to zero, then DMA is not supported;
c) 9 is set to one, then Multiword DMA mode 2 is supported;
d) 9 is cleared to zero, then Multiword DMA mode 2 is not supported;
e) 8 is set to one, then Multiword DMA mode 1 is supported;
f) 8 is cleared to zero, then Multiword DMA mode 1 is not supported;
g) 7 is set to one, then Multiword DMA mode 0 is supported;
h) 7 is cleared to zero, then Multiword DMA mode 0 is not supported;
i) 6 is set to one, then Ultra DMA mode 6 and below are supported;
j) 6 is cleared to zero, then Ultra DMA mode 6 and below are not supported;
k) 5 is set to one, then Ultra DMA mode 5 and below are supported;
l) 5 is cleared to zero, then Ultra DMA mode 5 and below are not supported;
m) 4 is set to one, then Ultra DMA mode 4 and below are supported;
n) 4 is cleared to zero, then Ultra DMA mode 4 and below are not supported;
o) 3 is set to one, then Ultra DMA mode 3 and below are supported;
p) 3 is cleared to zero, then Ultra DMA mode 3 and below are not supported;
q) 2 is set to one, then Ultra DMA mode 2 and below are supported;
r) 2 is cleared to zero, then Ultra DMA mode 2 and below are not supported;
s) 1 is set to one, then Ultra DMA mode 1 and below are supported;
t) 1 is cleared to zero, then Ultra DMA mode 1 and below are not supported;
u) 0 is set to one, then Ultra DMA mode 0 is supported; and
v) 0 is cleared to zero, then Ultra DMA mode 0 is not supported.

7.19.6.18 Word 63: Multiword DMA transfer

Word 63 identifies the Multiword DMA transfer modes supported by the device and indicates the mode that is currently selected . Only one DMA mode shall be selected at any given time . If an Ultra DMA mode is enabled, then no Multiword DMA mode shall be enabled . If a Multiword DMA mode is enabled, then no Ultra DMA mode shall be enabled.

Bits (15:11) of word 63 are reserved.

Bits (10:8) of word 63 shall have the content described for IDENTIFY DEVICE data word 63 . (see 7.18.7.24)

Bits (7:3) of word 63 are reserved

If bit 2 of Word 63 is set to one, then Multiword DMA modes 2 and below are supported . If this bit is cleared to zero, then Multiword DMA mode 2 is not supported . If Multiword DMA mode 2 is supported, then Multiword DMA modes 1 and 0 shall also be supported . If bit 2 of Word 63 is set to one, bits (1:0) shall be set to one.

For SATA devices, bit 2 of word 63 shall be set to one except this bit shall be cleared to zero for Serial ATAPI devices requiring the DMADIR bit in the PACKET command.

If bit 1 of Word 63 is set to one, then Multiword DMA modes 1 and below are supported . If this bit is cleared to zero, then Multiword DMA mode 1 is not supported . If Multiword DMA mode 1 is supported, then Multiword DMA mode 0 shall also be supported . If bit 1 of Word 63 is set to one, bit 0 shall be set to one .

For SATA devices, bit 1 of word 63 bit shall be set to one except this bit shall be cleared to zero for Serial ATAPI devices that require the DMADIR bit in the PACKET command.

If bit 0 of word 63 is set to one, then Multiword DMA mode 0 is supported . For SATA devices, this bit shall be set to one except this bit shall be cleared to zero for Serial ATAPI devices that require the DMADIR bit in the PACKET command.

7.19.6.19 Word 64: PIO transfer modes supported

Word 64 shall have the content described for IDENTIFY DEVICE data word 64 (see 7.18.7.25).

7.19.6.20 Word 65: Minimum multiword DMA transfer cycle time per word

Word 65 shall have the content described for IDENTIFY DEVICE data word 65 (see 7.18.7.26).

7.19.6.21 Word 66: Device recommended multiword DMA transfer cycle time

Word 66 shall have the content described for IDENTIFY DEVICE data word 66 (see 7.18.7.27).

7.19.6.22 Word 67: Minimum PIO transfer cycle time without flow control

Word 67 shall have the content described for IDENTIFY DEVICE data word 67 (see 7.18.7.28).

7.19.6.23 Word 68: Minimum PIO transfer cycle time with IORDY

Word 68 shall have the content described for IDENTIFY DEVICE data word 68 (see 7.18.7.29).

7.19.6.24 Words 69..70: Reserved

7.19.6.25 Words 71..72: Obsolete

7.19.6.26 Words 73..74: Reserved

7.19.6.27 Word 75: Obsolete

7.19.6.28 Word 76: Serial ATA Capabilities

Word 76 shall have the content described for IDENTIFY DEVICE data word 76 (see 7.18.7.34)

7.19.6.29 Word 77: Reserved for Serial ATA

7.19.6.30 Word 78: Serial ATA features supported

Word 78 shall have the content described for IDENTIFY DEVICE data word 78 (see 7.18.7.36)

7.19.6.31 Word 79: Serial ATA features enabled

Word 79 shall have the content described for IDENTIFY DEVICE data word 79 (see 7.18.7.37)

7.19.6.32 Word 80: Major version number

Word 80 shall have the content described for IDENTIFY DEVICE data word 80 (see 7.18.7.38).

7.19.6.33 Word 81: Minor version number

Word 81 shall have the content described for IDENTIFY DEVICE data word 81 (see 7.18.7.39).

7.19.6.34 Words 82..84, 119: Commands and feature sets supported

Words 82..84 and 119 shall have the content described for IDENTIFY DEVICE data words 82..84 and 119 (see 7.18.7.40) except as specified in table 65.

7.19.6.35 Words 85..87, 120: Commands and feature sets supported or enabled

Words 85..87 and 120 shall have the content described for IDENTIFY DEVICE data words 85..87 and 120 (see 7.18.7.41) except as specified in table 65.

7.19.6.36 Word 88:Ultra DMA modes

Word 88 shall have the content described for IDENTIFY DEVICE data word 88 (see 7.18.7.42), except bits (6:0) shall be cleared to zero for Serial ATAPI devices that require the DMADIR bit in the PACKET command.

7.19.6.37 Word 89: Time required for Normal Erase mode SECURITY ERASE UNIT command

Word 89 shall have the content described for IDENTIFY DEVICE data word 89 (see 7.18.7.43).

7.19.6.38 Word 90: Time required for an Enhanced Erase mode SECURITY ERASE UNIT command

Word 90 shall have the content described for IDENTIFY DEVICE data word 90 (see 7.18.7.44).

7.19.6.39 Word 91: Current APM level value

Word 91 shall have the content described for IDENTIFY DEVICE data word 91 (see 7.18.7.45)

7.19.6.40 Word 92: Master Password Identifier

Word 92 shall have the content described for IDENTIFY DEVICE data word 92 (see 7.18.7.46).

7.19.6.41 Word 93: Hardware reset results

Word 93 shall have the content described for IDENTIFY DEVICE data word 93 (see 7.18.7.47).

7.19.6.42 Word 94: Current automatic acoustic management value

Word 94 shall have the content described for IDENTIFY DEVICE data word 94 (see 7.18.7.48).

7.19.6.43 Word 95..107: Reserved

7.19.6.44 Words 108..111: World wide name

Words 108..111 shall have the content described for IDENTIFY DEVICE data words 108..111 (see 7.18.7.58).

7.19.6.45 Words 112..115: Reserved for a 128-bit world wide name

7.19.6.46 Words 116..118: Reserved

7.19.6.47 Words 119..120: See words 82..84 and words 85..87

7.19.6.48 Words 121..124: Reserved

7.19.6.49 Word 125 ATAPI byte count = 0 behavior

If the contents of word 125 are 0000h and the value of the Byte Count Limit is zero, then the device shall return command aborted.

If the contents of word 125 are non-zero and the value of the Byte Count Limit is zero, then the device shall use the contents of word 125 as the actual byte count limit for the current command and shall not abort.

The device may be reconfigured to report a new value . However, after the device is reconfigured, the content of word 125 reported shall not change until after the next power-on reset or hardware reset.

7.19.6.50 Word 126..127: Obsolete

7.19.6.51 Word 128: Security status

Word 128 shall have the content described for IDENTIFY DEVICE data word 128 (see 7.18.7.66).

7.19.6.52 Words 129..159: Reserved

7.19.6.53 Words 160..175: Reserved for assignment by the CompactFlash Association

7.19.6.54 Words 176..221: Reserved

7.19.6.55 Word 222: Transport major version number

Word 222 shall have the content described for IDENTIFY DEVICE data word 222 (see 7.18.7.86).

7.19.6.56 Word 223: Transport minor version number

Word 223 shall have the content described for IDENTIFY DEVICE data word 223 (see 7.18.7.87).

7.19.6.57 Words 224..254: Reserved

7.19.6.58 Word 255: Integrity word

Word 255 shall have the content described for IDENTIFY DEVICE data word 255 (see 7.18.7.93).

7.20 IDLE - E3h, Non-Data

7.20.1 Feature Set

This 28-bit command is for devices implementing the Power Management feature set (see 4.19).

7.20.2 Description

The IDLE command places the device in the Idle mode and sets the Standby timer . Command completion may occur even though the device has not fully transitioned into the Idle mode.

If the host sets the Count field to 00h, then the device shall disable its Standby timer (see 4.19) . If the host sets the Count field to a value > 00h, then table 67 defines the Standby timer value.

7.20.3 Inputs

See table 66 for the IDLE command inputs.

Table 66 — IDLE command inputs

Name	Description
Feature	Reserved
Count	This value shall determine the time period programmed into the Standby timer . Table 67 defines these values
LBA	Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 E3h

Table 67 — Standby timer periods

Count field	Description
00h	Standby time disabled
01h-F0h	(value * 5) seconds (i.e., 5 seconds to 1 200 seconds (i.e., 20 minutes))
F1h-FBh	((value - 240) * 30) minutes (i.e., 30 minutes to 330 minutes (i.e., 5.5 hours))
FCh	21 minutes
FDh	Between 8 hours and 12 hours
FEh	Reserved
FFh	21 minutes 15 seconds
Note - Times are approximate.	

7.20.4 Normal Outputs

See table 215.

7.20.5 Error Outputs

See table 239.

7.21 IDLE IMMEDIATE - E1h, Non-Data

7.21.1 Feature Set

This 28-bit command is for devices implementing the Power Management feature set (see 4.19).

7.21.2 Description

7.21.2.1 Default Function

The IDLE IMMEDIATE command places the device in the Idle mode . Command completion may occur even though the device has not fully transitioned into the Idle mode.

7.21.2.2 Unload feature

The unload feature of the IDLE IMMEDIATE command causes a device that has movable read/write heads to move them to a safe position.

Upon receiving an IDLE IMMEDIATE command with the unload feature, a device shall:

   a) stop read look-ahead if that operation is in process;
   b) stop writing cached data to the media if that operation is in process;
   c) if a device implements unloading its head(s) onto a ramp, then the device shall retract the head(s) onto the ramp;
   d) if a device implements parking its head(s) in a landing zone on the media, then the device shall park its head(s) in the landing zone; and
   e) transition to the Idle mode.

The device shall retain data in the write cache and resume writing the cached data onto the media after receiving a software reset, a hardware reset, or any new command except IDLE IMMEDIATE command with unload feature.

A device shall report command completion after the head(s) have been unloaded or parked.

> NOTE 15 — The time required by a device to complete an unload or park operation is vendor specific.

7.21.3 Inputs (Default Function)

See table 68 for the IDLE IMMEDIATE command inputs.

Table 68 — IDLE IMMEDIATE command inputs

Name	Description
Feature	N/A except when the unload feature is requested, see 7.21.4
Count	N/A except when the unload feature is requested, see 7.21.4
LBA	N/A except when the unload feature is requested, see 7.21.4
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 E1h

7.21.4 Inputs (Unload Feature)

See table 69 for the IDLE IMMEDIATE with Unload command inputs.

Table 69 — IDLE IMMEDIATE with Unload command inputs

Name	Description
Feature	44h
Count	00h
LBA	055_4E4Ch

Device	**Bit Description**
	
	  7 Obsolete
	
	  6 N/A
	
	  5 Obsolete
	
	  4 Transport Dependent - See 6.2.12
	
	3:0 Reserved

Command	7:0 E1h

7.21.5 Normal Outputs (default)

See table 215.

7.21.6 Normal Outputs (unload feature)

See table 222.

7.21.7 Error Outputs

See table 239.

7.22 Non-Volatile Cache

7.22.1 NV Cache Overview

The NV Cache feature set modifies the NV Cache Pinned Set of a device allowing the device to improve response times to read and write commands while reducing the device's power consumption.

The NV Cache feature set provides a set of commands that allow control of a device's management of the contents of its NV Cache.

Commands unique to the NV Cache feature set use a single command code and are differentiated from one another by the value placed in the Feature field . A device that implements the NV Cache Commands feature set shall implement the following commands:

A) ADD LBA(S) TO NV CACHE PINNED SET;
B) REMOVE LBA(S) FROM NV CACHE PINNED SET;
C) QUERY NV CACHE PINNED SET;
D) QUERY NV CACHE MISSES;
e) FLUSH NV CACHE; and
f) NV CACHE ENABLE/DISABLE.

Individual NV Cache Commands are identified by the value placed in the Feature field as shown in table 70.

Table 70 — NV Cache Commands

Value	Command Name
0000h-000Fh	Reserved for the NV Cache Power Management feature set
0010h	ADD LBA(S) TO NV CACHE PINNED SET
0011h	REMOVE LBA(S) FROM NV CACHE PINNED SET
0012h	QUERY NV CACHE PINNED SET
0013h	QUERY NV CACHE MISSES
0014h	FLUSH NV CACHE
0015h	NV CACHE ENABLE
0016h	NV CACHE DISABLE
0017h-002Fh	Reserved for the NV Cache feature set
0030h-00CFh	Reserved
00D0h-00EFh	Vendor Specific
00F0h-FFFFh	Reserved

7.22.2 NV Cache Power Management Overview

The NV Cache Power Management feature set modifies the behavior of a device allowing the device to improve response times to read and write commands while reducing the device's power consumption .

Commands unique to the NV Cache Power Management feature set use a single command code and are differentiated from one another by the value placed in the Feature field . A device that implements the NV Cache Power Management feature set shall implement the following commands:

a) SET NV CACHE POWER MODE; and
B) RETURN FROM NV CACHE POWER MODE.

Individual NV Cache Power Management commands are identified by the value placed in the Feature field as shown in table 71.

Table 71 — NV Cache Power Management Commands

Value	Command Name
0000h	SET NV CACHE POWER MODE
0001h	RETURN FROM NV CACHE POWER MODE
0002h-000Fh	Reserved for the NV Cache Power Management feature set
0010h-002Fh	Reserved for the NV Cache feature set
0030h-00CFh	Reserved
00D0h-00EFh	Vendor Specific
00F0h-FFFFh	Reserved

7.22.3 ADD LBA(S) TO NV CACHE PINNED SET - B6h/10h, DMA

7.22.3.1 Feature set

This 48-bit command is for devices implementing the NV Cache feature set (see 4.17).

7.22.3.2 Description

The ADD LBA(S) TO NV CACHE PINNED SET command adds the logical blocks specified in the NV Cache Set Data to the NV Cache Pinned Set.

If the PI bit is set to one, then the command shall not complete until the device has transferred all of the logical sector data into the NV Cache Pinned Set . If the PI bit is cleared to zero, then the command shall complete before the device has transferred any of the logical sectors into the NV Cache Pinned Set and the logical sector data shall be transferred into the NV Cache Pinned Set on subsequent Write operations . If a Read operation occurs to an LBA marked with the PI bit cleared to zero before the logical sector data is received, then this data shall be sourced from the valid data located outside of the NV Cache Pinned Set and may require a disk spin up.

If an LBA Range Entry (see 7.22.3.6) specified in the NV Cache Set Data does exist but is beyond the range of user addressable logical blocks, the device shall add the logical blocks to the NV Cache Pinned Set, but continue to fail all reads and writes to the LBA as before.

The response to this command shall be the number of logical sectors that may be added to the NV Cache's pinned set.

7.22.3.3 Inputs

7.22.3.3.1 Overview

See table 72 for the ADD LBA(S) TO NV CACHE PINNED SET command inputs.

Table 72 — ADD LBA(S) TO NV CACHE PINNED SET command inputs

Name	Description
Feature	0010h
Count	Number of 512-byte data blocks to be transferred . 0000h specifies that 65 536 blocks shall be transferred
LBA	**Bit Description** 47:1 Reserved 0 Populate Immediately (PI) - See 7.22.3.3.2
Device	**Bit Description** 7:5 N/A 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B6h

7.22.3.3.2 Populate Immediately

If the PI (Populate Immediately) bit is set to one, then the device shall add the logical blocks specified in the Pin Request Data (see table 73) to the device's NV Pinned Cache Set and populated with the specified data from the rotating media before command completion.

If PI is cleared to zero, then the logical blocks specified in the Pin Request Data shall be added to the device's NV Pinned Cache Set and:

a) the LBA in the pinned set shall be populated with data from a subsequent write operation; and

b) the LBA in the pinned set may be populated with data from a subsequent read operation.

7.22.3.4 Normal Outputs

See table 229.

7.22.3.5 Error Outputs

If this command fails, none of the requested logical blocks are added to the NV Cache Pinned Set . See table 266 for more information.

7.22.3.6 Output From the Host to the Device Data Structure

Pin Request Data is a list of individual LBA ranges . Each entry in the Pin Request Data is called a LBA Range Entry (see 4.17.3.2) . If the range length is zero then the LBA Range Entry is not valid . The range entries shall be non-overlapping and shall be sorted with the LBA values in ascending order.

Table 73 — LBA Range Entries

Offset	Type	Description

0..7	QWord	Entry #0
		    63:48 Range Length
		    47:0 LBA Value

8..15	QWord	Entry #1
		    63:48 Range Length
		    47:0 LBA Value

...		...

496..511	QWord	Entry #63
		    63:48 Range Length
		    47:0 LBA Value

7.22.4 FLUSH NV CACHE - B6h/14h, Non-Data

7.22.4.1 Feature set

This 48-bit command is for devices implementing the NV Cache feature set (see 4.17).

7.22.4.2 Description

The FLUSH NV CACHE command, requests the device to provide at least as many logical blocks as are specified in LBA (31:0) for use by the NV Cache Pinned Set . If necessary the device flushes logical blocks from the NV Cache Unpinned Set to provide the capacity requested . The device may spin-up to complete this command . The logical blocks shall remain available until the next reset or NV Cache feature set command is processed by the device.

7.22.4.3 Inputs

See table 74 for the ADD LBA(S) TO NV CACHE PINNED SET command inputs.

Table 74 — ADD LBA(S) TO NV CACHE PINNED SET command inputs

Name	Description
Feature	0014h
Count	Reserved
LBA	**Bit Description** 47:32 Reserved 31:0 Minimum number of logical blocks to flush
Device	**Bit Description** 7:5 N/A 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B6h

7.22.4.4 Normal Outputs

The number of unflushed logical blocks is the number of logical blocks that have yet to be flushed from the NV Cache Unpinned Set to satisfy the Minimum Number of logical blocks to flush or the number of logical blocks to empty from the NV Cache Unpinned Set, whichever is less . See table 230.

7.22.4.5 Error Outputs

See table 268.

7.22.5 NV CACHE DISABLE- B6h/16h, Non-Data

7.22.5.1 Feature set

This 48-bit command is for devices implementing the NV Cache feature set (see 4.17).

7.22.5.2 Description

The NV CACHE DISABLE command shall cause the device to perform the following actions:

    a) flush all non-volatile cached data (i.e., pinned and unpinned data) to other non-volatile media;
    b) erase the pinned logical sectors list;
    c) disable the NV Cache Power Management feature set; and
    d) no longer read user data from or write user data to the non-volatile cache.

Once the device has reported successful command completion, the device shall return command aborted for all commands in the NV Cache feature set except for NV CACHE ENABLE command (see 7.22.6).

This setting is non-volatile.

7.22.5.3 Inputs

See table 75 for the NV CACHE DISABLE command inputs.

Table 75 — NV CACHE DISABLE command inputs

Name	Description
Feature	0016h
Count	Reserved
LBA	Reserved
Device	**Bit** **Description** 7:5 N/A 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B6h

7.22.5.4 Normal Outputs

See table 227.

7.22.5.5 Error Outputs

See table 268.

7.22.6 NV CACHE ENABLE - B6h/15h, Non-Data

7.22.6.1 Feature set

This 48-bit command is for devices implementing the NV Cache feature set (see 4.17).

7.22.6.2 Description

The NV CACHE ENABLE command allows the device to read data from or write data to the non-volatile cache.

This setting is non-volatile.

7.22.6.3 Inputs

See table 76 for the NV CACHE ENABLE command inputs.

Table 76 — NV CACHE ENABLE command inputs

Name	Description
Feature	0015h
Count	Reserved
LBA	Reserved
Device	**Bit Description** 7:5 N/A 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B6h

7.22.6.4 Normal Outputs

See table 227.

7.22.6.5 Error Outputs

See table 268.

7.22.7 QUERY NV CACHE MISSES - B6h/13h, DMA

7.22.7.1 Feature set

This 48-bit command is for devices implementing the NV Cache feature set (see 4.17).

7.22.7.2 Description

The QUERY NV CACHE MISSES command requests the device to report Cache Miss Data (see table 78) in LBA Ranges in a single 512-byte block . The first 64 cache misses are returned as LBA Ranges and shall be listed in accessed order . If the device does not have as many LBA ranges as are requested in the transfer, the unused LBA ranges shall be filled with zeroes.

Any of the following conditions shall cause the Cache Miss Data to be cleared:

    a)   the device processes a power-on reset;
    b)   the devices completes a QUERY NV CACHE MISSES command; or
    c)   the device completes a STANDBY IMMEDIATE command.

7.22.7.3 Inputs

See table 77 for the QUERY NV CACHE MISSES command inputs.

Table 77 — QUERY NV CACHE MISSES command inputs

Name	Description
Feature	0013h
Count	0001h
LBA	Reserved
Device	**Bit Description** 7:5 N/A 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B6h

7.22.7.4 Normal Outputs

See table 229.

7.22.7.5 Error Outputs

See table 269.

7.22.7.6 Input From the Device to the Host Data Structure

Cache Miss Data is a list of individual LBA ranges . Each entry in Cache Miss Data is called a LBA Range Entry (see 4.17.3.2) and is represented by 8 bytes . If the range length is zero then the LBA Range Entry is not valid.

Table 78 — Cache Miss Data

Offset	Type	Description
0..7	QWord	Entry #0
		63:48 Range Length
		47:0 LBA Value
8..15	QWord	Entry #1
		63:48 Range Length
		47:0 LBA Value
...		...
496..511	QWord	Entry #63
		63:48 Range Length
		47:0 LBA Value

7.22.8 QUERY NV CACHE PINNED SET - B6h/12h, DMA

7.22.8.1 Feature set

This 48-bit command is for devices implementing the NV Cache feature set (see 4.17).

7.22.8.2 Description

The QUERY NV CACHE PINNED SET command requests the device to send the LBA Ranges currently in the NV Cache Pinned Set in one or more 512-byte blocks equal to the number in Block Count . If a device does not have as many LBA Ranges as are requested in the transfer, the unused LBA Range Entries shall be filled with zero.

7.22.8.3 Inputs

See table 79 for the QUERY NV CACHE PINNED SET command inputs.

Table 79 — QUERY NV CACHE PINNED SET command inputs

Name	Description
Feature	0012h
Count	Number of 512-byte data blocks to be transferred . 0000h specifies that 65 536 blocks shall be transferred
LBA	Starting 512-byte data block . The first 512-byte data block is numbered zero.
Device	**Bit Description** 7:5 N/A 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B6h

7.22.8.4 Normal Outputs

See table 229.

7.22.8.5 Error Outputs

See table 269.

7.22.8.6 Input From the Device to the Host Data Structure

Pin Set Data is a list of individual LBA ranges . Each entry in Pin Set Data is called a LBA Range Entry (see 4.17.3.2) and is represented by eight bytes . The LBA Range Entries shall be sent in ascending numerical order by LBA value.

Table 80 — Pin Set Data

Offset	Word	Description
0..7	QWord	Entry #0
		63:48 Range Length
		47:0 LBA Value
8..15	QWord	Entry #1
		63:48 Range Length
		47:0 LBA Value
...		...
496..511	QWord	Entry #63
		63:48 Range Length
		47:0 LBA Value

7.22.9 REMOVE LBA(S) FROM NV CACHE PINNED SET - B6h/11h, DMA/Non-Data

7.22.9.1 Feature set

This 48-bit command is for devices implementing the NV Cache feature set (see 4.17).

7.22.9.2 Description

The REMOVE LBA(S) FROM NV CACHE PINNED SET command removes the logical blocks specified in the NV Cache Set Data from the NV Cache's pinned set . This command may not remove the logical blocks from the NV Cache.

If the NV Cache Set Data specifies an LBA not in the NV Cache Pinned Set, the LBA shall be ignored without causing an error.

The response to this command shall be the number of additional logical blocks that the host may add to the NV Cache's pinned working set as specified in the Count and LBA fields.

7.22.9.3 Inputs

7.22.9.3.1 Overview

See table 81 for the QUERY NV CACHE PINNED SET command inputs.

Table 81 — QUERY NV CACHE PINNED SET command inputs

Name	Description
Feature	0011h
Count	Number of 512-byte data blocks to be transferred . 0000h specifies that 65 536 blocks shall be transferred
LBA	**Bit Description** 47:1 Reserved 0 Unpin All (UA) - See 7.22.9.3.2
Device	**Bit Description** 7:5 N/A 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B6h

7.22.9.3.2 Unpin All

If the UA (Unpin All) bit is set to one, then the device shall:

   a)   ignore the value in the Count field;
   b)   unmap all logical blocks in the NV Cache Pinned Set; and
   c)   use the Non-Data protocol.

7.22.9.4 Normal Outputs

See table 229.

7.22.9.5 Error Outputs

If a device completes this command with an error, then none of the requested logical blocks are removed from the NV Cache Pinned Set . See table 267.

7.22.9.6 Output From the Host to the Device Data Structure

Remove Pin Data is a list of individual LBA ranges . Each entry in Remove Pin Data is called a LBA Range Entry (see 4.17.3.2) and is represented by eight bytes . If the range length is zero then the LBA Range Entry is not valid . The range entries shall be non-overlapping and sorted with the LBA Values in ascending order

Table 82 — Remove Pin Data

Offset	Type	Description
0..7	QWord	Entry #0
		63:48 Range Length
		47:0 LBA Value
8..15	QWord	Entry #1
		63:48 Range Length
		47:0 LBA Value
...		...
496..511	QWord	Entry #63
		63:48 Range Length
		47:0 LBA Value

7.22.10 RETURN FROM NV CACHE POWER MODE - B6h/01h, Non-Data

7.22.10.1 Feature set

This 48-bit command is for devices implementing the NV Cache Power Management feature set (see 4.18).

7.22.10.2 Description

The RETURN FROM NV CACHE POWER MODE command shall cause the device to disable the NV Cache power mode and clear IDENTIFY DEVICE data word 214 bit 1 (see 7.18.7.79) . Upon completion of this command the device shall disable the NV Cache power mode timer (see 4.19.4).

This command shall not enable or disable the non-volatile cache or the NV Cache feature set.

7.22.10.3 Inputs

See table 83 for the QUERY NV CACHE PINNED SET command inputs.

Table 83 — QUERY NV CACHE PINNED SET command inputs

Name	Description
Feature	0001h
Count	Reserved
LBA	Reserved
Device	**Bit Description** 7:5 N/A 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B6h

7.22.10.4 Normal Outputs

See table 215.

7.22.10.5 Error Outputs

See table 242.

7.22.11 SET NV CACHE POWER MODE - B6h/00h, Non-Data

7.22.11.1 Feature set

This 48-bit command is for devices implementing the NV Cache Power Management feature set (see 4.18).

7.22.11.2 Description

The SET NV CACHE POWER MODE command shall cause the device to set the NV Cache power mode timer and set IDENTIFY DEVICE data word 214 bit 1 to one (see 7.18.7.79) . The device should minimize power consumption and use the NV Cache to complete read and write requests whenever possible.

When the device spins-up its rotating media, the rotating media shall remain spun-up for at least as many seconds as the value in the Count field.

If the Standby timer or the Standby_y timer or the Standby_z timer (see 4.9) expires before the NV Cache power mode timer (see 4.19.4), the device shall not transition to Standby mode until the NV Cache power mode timer expires . APM shall not cause the device to transition to a lower power state until the NV Cache power mode timer expires.

7.22.11.3 Inputs

7.22.11.3.1 Overview

See table 84 for the QUERY NV CACHE PINNED SET command inputs.

Table 84 — QUERY NV CACHE PINNED SET command inputs

Name	Description
Feature	0000h
Count	Minimum High-Power Time - See 7.22.11.3.2
LBA	Reserved
Device	**Bit Description** 7:5 N/A 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B6h

7.22.11.3.2 Minimum High-Power Time

Minimum High-Power Time contains the minimum value, in seconds, that the device shall stay in the Active state or Idle state (see 4.19.4) when the device needs to enter the high power state to access its media while NV CACHE power mode is set . The high power state may include any Power Management state in which the media is spun up and available.

The maximum amount of time the device shall keep the media spun up is vendor specific.

7.22.11.4 Normal Outputs

See table 215.

7.22.11.5 Error Outputs

See table 242.

7.23 NOP - 00h, Non-Data

7.23.1 Feature Set

This 28-bit command is for ATA devices (see 4.2) and ATAPI devices (see 4.3).

7.23.2 Description

The NOP command shall complete with an error.

7.23.3 Inputs

See table 85 for the NOP command inputs.

Table 85 — NOP command inputs

Name	Description
Feature	Subcommand Code (see table 86)
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 00h

Table 86 — NOP Subcommand Code

Subcommand Code	Description	Action
00h	NOP	Return command aborted.
01h-FFh	Obsolete	

7.23.4 Normal Outputs

When processed by a device, this command always fails with an error (see table 86).

The Count and LBA fields retain the values that were present when the NOP command was accepted.

7.23.5 Error Outputs

See table 258.

7.24 PACKET - A0h, Packet

7.24.1 Feature Set

This 28-bit command is for devices implementing the PACKET feature set (see 4.3).

7.24.2 Description

The PACKET command transfers a SCSI CDB via a command packet . If the native form of the encapsulated command is shorter than the packet size reported in IDENTIFY PACKET DEVICE data word 0 bits (1:0) (see 7.19.6.2), then the encapsulated command shall begin at byte 0 of the packet . Packet bytes beyond the end of the encapsulated command are reserved.

7.24.3 Inputs

See table 87 for the PACKET command inputs.

Table 87 — PACKET command inputs

Name	Description
Feature	**Bit Description** 7:3 Reserved 2 DMADIR - See 7.24.4 1 Obsolete 0 DMA - This bit is set to one to inform the device that the data transfer (i.e., not the command packet transfer) associated with this command is via Multiword DMA or Ultra DMA mode.
Count	**Bit Description** 7:3 Obsolete 2:0 N/A
LBA	**Bit Description** 27:24 Reserved 23:8 Byte Count Limit - See 7.24.5 7:0 Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 A0h

7.24.4 DMADIR

The DMADIR bit indicates the direction of the DMA data transfer for the PACKET command and is used only for ATAPI devices that require direction indication from the host . If IDENTIFY PACKET DEVICE data word 62 bit 15 (see 7.19.6.17) is set to one, then the device requires the use of the DMADIR bit for DMA data transfer for PACKET commands.

If the device requires the DMADIR bit to be set to one for a DMA data transfer for a PACKET command (i.e., bit 0, the DMA bit, is set to one), then this bit indicates the direction of data transfer (i.e., 0 = transfer to the device, and 1 = transfer to the host) . If the device requires the DMADIR bit to be set for a DMA data transfer for a PACKET command, but the current operation is a PIO data transfer (i.e., bit 0, the DMA bit, is cleared to zero), then this bit is ignored.

Since the data transfer direction is set by the host as the command is constructed, the DMADIR bit should not conflict with the data transfer direction of the command . If a conflict between the command transfer direction and the DMADIR bit occurs, the device should return with an ABORTED command, and the sense key set to ILLEGAL REQUEST.

If the device does not require the DMADIR bit to be set for a DMA data transfer for a PACKET command, then this bit should be cleared to zero.

A device that does not support the DMADIR feature may return command aborted for a command if the DMADIR bit is set to one.

7.24.5 Byte Count Limit

The Byte Count Limit is the maximum byte count that is to be transferred in any single DRQ data block for PIO transfers . The Byte Count Limit does not apply to the command packet transfer . If the PACKET command does not transfer data, the Byte Count Limit is ignored.

> NOTE 16 — The amount of data transferred by this command is specified in the CDB.

If the PACKET command results in a data transfer, then:

a) the host should not set the Byte Count Limit to zero (see 7.19.6.49);
b) if the total requested data transfer length is greater than the Byte Count Limit, then the value set into the Byte Count Limit shall be even;
c) if the total requested data transfer length is equal to or less than the Byte Count Limit, then the value set into the Byte Count Limit may be odd; and
d) the value FFFFh shall be interpreted by the device as though the value were FFFEh.

7.24.6 Normal Outputs

7.24.6.1 Awaiting command

When the device is ready to accept the command packet from the host the return structure shall be set according to table 223 . The Input/Output bit shall be cleared to zero, and the Command/Data bit shall be set to one . The Byte Count Limit shall reflect the value set by the host when the command was issued.

7.24.6.2 Data transmission

Data transfer shall occur after the receipt of the command packet . See table 223 for the return structure when the device is ready to transfer data requested by a data transfer command . Input/Output is ignored, and Command/Data shall be set to zero.

If the transfer is to be in PIO mode, then the byte count of the data to be transferred for this DRQ data block shall be:

a) not equal to zero;
b) less than or equal to the byte count limit value received from the host;
c) less than or equal to FFFEh; and
d) even if this is not the last transfer of a command.

If this is the last transfer for a command in PIO mode, then the byte count for the DRQ data block may be odd . If the byte count for the DRQ data block is odd, then the last byte transferred shall be a pad byte (i.e., to make the total number of bytes transferred be even) . The value of the pad byte is undefined.

7.24.6.3 Successful command completion

When the device has command completion without error, the device returns the data structure found in table 223 . Input/Output shall be set to one, Command/Data shall be set to one . Byte Count is reserved at command completion.

7.24.7 Error Outputs

The device shall not terminate the PACKET command with an error before the last byte of the command packet has been written . See table 259.

7.25 READ BUFFER - E4h, PIO Data-In

7.25.1 Feature Set

This 28-bit command is for ATA devices (see 4.2).

7.25.2 Description

The READ BUFFER command enables the host to read a 512-byte block of data.

The READ BUFFER command and WRITE BUFFER command shall be synchronized such that sequential WRITE BUFFER command and READ BUFFER command access the same data.

The command prior to a READ BUFFER command should be a WRITE BUFFER command . If the READ BUFFER command is not preceded by a WRITE BUFFER command, the data returned by READ BUFFER command may be indeterminate.

7.25.3 Inputs

See table 88 for the READ BUFFER command inputs.

Table 88 — READ BUFFER command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 E4h

7.25.4 Normal Outputs

See table 215.

7.25.5 Error Outputs

A device may return command completion with the Error bit set to one if an Interface CRC error has occurred . See table 240.

> NOTE 17 — There is no defined mechanism for a device to return an Interface CRC error status that may have occurred during the last data block of a PIO-in data transfer . There may be other mechanisms in which a host may verify that an Interface CRC error occurred in these cases.

7.26 READ BUFFER DMA - E9h, DMA

7.26.1 Feature Set

This 28-bit command is for ATA devices (see 4.2).

7.26.2 Description

See 7.25.2.

7.26.3 Inputs

See table 89 for the READ BUFFER DMA command inputs.

Table 89 — READ BUFFER DMA command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 E9h

7.26.4 Normal Outputs

See 7.25.4.

7.26.5 Error Outputs

See 7.25.5.

7.27 READ DMA - C8h, DMA

7.27.1 Feature Set

This 28-bit command is for ATA devices (see 4.2).

7.27.2 Description

The READ DMA command allows the host to read data using the DMA data transfer protocol.

7.27.3 Inputs

See table 90 for the READ DMA command inputs.

Table 90 — READ DMA command inputs

Name	Description
Feature	N/A
Count	The number of logical sectors to be transferred . A value of 00h indicates that 256 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 C8h

7.27.4 Normal Outputs

See table 215.

7.27.5 Error Outputs

If an unrecoverable error occurs while the device is processing this command, then the device shall return command completion with the Error bit set to one and the LBA field set to the LBA of the logical sector where the first unrecoverable error occurred . The validity of the data transferred is indeterminate . See table 249.

7.28 READ DMA EXT - 25h, DMA

7.28.1 Feature Set

This 48-bit command is for devices implementing the 48-bit Address feature set (see 4.4).

7.28.2 Description

The READ DMA EXT command allows the host to read data using the DMA data transfer protocol.

7.28.3 Inputs

See table 91 for the READ DMA EXT command inputs.

Table 91 — READ DMA EXT command inputs

Name	Description
Feature	Reserved
Count	The number of logical sectors to be transferred . A value of 0000h indicates that 65 536 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 25h

7.28.4 Normal Outputs

See table 227.

7.28.5 Error Outputs

If an unrecoverable error occurs while the device is processing this command, then the device shall return command completion with the Error bit set to one and the LBA field set to the LBA of the logical sector where the first unrecoverable error occurred . The validity of the data transferred is indeterminate . See table 247.

7.29 READ FPDMA QUEUED - 60h, DMA Queued

7.29.1 Feature Set

This 48-bit command is for devices implementing the NCQ feature set (see 4.16).

7.29.2 Description

The READ FPDMA QUEUED command requests data to be transferred from the device to the host.

7.29.3 Inputs

7.29.3.1 Overview

See table 92 for the READ FPDMA QUEUED command inputs.

Table 92 — READ FPDMA QUEUED command inputs

Name	Description
Feature	The number of logical sectors to be transferred . A value of 0000h indicates that 65 536 logical sectors are to be transferred
Count	**Bit Description** 15 PRIO - See 7.29.3.2 14:8 Reserved 7:3 NCQ Tag - See 6.5.2 2:0 N/A
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7 FUA - See 7.29.3.3 6 Shall be set to one 5 Reserved 4 Shall be set to zero 3:0 Reserved
Command	7:0 60h

7.29.3.2 Priority (PRIO)

The Priority (PRIO) value shall be assigned by the host based on the priority of the command issued . If PRIO is set to one, then the command shall be high priority . If PRIO is cleared to zero, then the command shall be normal priority . The device shall make a best effort to complete high priority requests in a more timely fashion than normal priority requests.

7.29.3.3 Forced Unit Access (FUA)

When the FUA bit is set to one the device shall retrieve the data from the non-volatile media regardless of whether the device holds the requested information in its volatile cache . If the device holds a modified copy of the requested data as a result of having volatile cached writes, the modified data shall be written to the non-volatile media before being retrieved from the non-volatile media as part of this operation . When the FUA bit is cleared to zero the data shall be retrieved either from the device's non-volatile media or cache.

7.29.4 Command Acceptance Outputs

See table 231.

7.29.5 Normal Outputs

See table 232.

7.29.6 Error Outputs

This return indicates that the command was aborted due to LBA out of range, a duplicate tag number, an invalid tag number, or an Interface CRC error, see table 270 for more information.

Errors that occur during the processing of this command are reported by returning a transport dependent indicator with additional information available in the NCQ Command Error log . The validity of the data transferred is indeterminate . See table 272.

7.30 READ LOG EXT - 2Fh, PIO Data-In

7.30.1 Feature Set

This 48-bit command is for devices implementing the GPL feature set (see 4.11).

7.30.2 Description

The READ LOG EXT command returns the specified log to the host . See table A.2 for the list of logs.

7.30.3 Inputs

7.30.3.1 Overview

All the logs in this standard reserve the Feature field unless otherwise specified . See table 93 for the READ LOG EXT command inputs.

Table 93 — READ LOG EXT command inputs

Name	Description
Feature	Log Specific
Count	Block Count - See 7.30.3.2
LBA	**Bit Description** 47:40 Reserved 39:32 Page # (15:8) - See 7.30.3.4. 31:16 Reserved 15:8 Page # (7:0) - See 7.30.3.4. 7:0 Log Address - See 7.30.3.3.
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 2Fh

7.30.3.2 Block Count

Specifies the number of 512-byte blocks of data to be read from the specified log . The log transferred by the device shall start at the block of data in the specified log at the specified offset, regardless of the block count requested . A value of zero is illegal and shall result in command aborted.

7.30.3.3 Log Address

Specifies the log to be read as described in table A.2 . A device may support a subset of the available logs . Support for individual logs is determined by support for the associated feature set . Support of the associated log(s) is mandatory for devices implementing the associated feature .

7.30.3.4 Page

Specifies the first log page (see 3.1.48) to be read from the specified log address . The first page number shall be zero.

7.30.4 Normal Outputs

See table 227.

7.30.5 Error Outputs

A device shall return command aborted if:

  a) the feature set associated with the log specified in the LBA field (7:0) is not supported or not enabled;
  b) the values in other fields are invalid (e.g., the Count field is cleared to zero); or
  c) the value in the Page # field plus the value in the Count field is larger than the log size reported in the General Purpose Log Directory.

A device may return command aborted if an Interface CRC error has occurred . The validity of the data transferred is indeterminate.

 See table 248.

> NOTE 18 — There is no defined mechanism for a device to return an Interface CRC error status that may have occurred during the last data block of a PIO-in data transfer . There may be other mechanisms in which a host may verify that an Interface CRC error occurred in these cases.

7.31 READ LOG DMA EXT - 47h, DMA

7.31.1 Feature Set

This 48-bit command is for devices implementing the General Purpose Logging feature set (see 4.11).

7.31.2 Description

See 7.30.2.

7.31.3 Inputs

All the logs in this standard reserve the Feature field unless otherwise specified . See table 94 for the READ LOG DMA EXT command inputs.

Table 94 — READ LOG DMA EXT command inputs

Name	Description
Feature	Log Specific
Count	Block Count - See 7.30.3.2
LBA	**Bit** **Description** 47:40 Reserved 39:32 Page # (15:8) - See 7.30.3.4. 31:16 Reserved 15:8 Page # (7:0) - See 7.30.3.4. 7:0 Log Address - See 7.30.3.3.
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 47h

7.31.4 Normal Outputs

See 7.30.4.

7.31.5 Error Outputs

See 7.30.5.

7.32 READ MULTIPLE - C4h, PIO Data-In

7.32.1 Feature Set

This 28-bit command is for ATA devices (see 4.2).

7.32.2 Description

The READ MULTIPLE command reads the number of logical sectors specified in the Count field.

The number of logical sectors per DRQ data block is defined by the content of IDENTIFY DEVICE data word 59 (see 7.18.7.21) . The device shall interrupt for each DRQ data block transferred.

If the number of requested logical sectors is not evenly divisible by the DRQ data block count (see 7.53), as many full DRQ data blocks as possible are transferred, followed by a final, partial DRQ data block transfer.

Device errors encountered during READ MULTIPLE commands are returned at the beginning of the DRQ data block or partial DRQ data block transfer.

If a READ MULTIPLE command is received by the device and:

   a) IDENTIFY DEVICE data word 59 bit 8 (see 7.18.7.21) is cleared to zero; or
   b) IDENTIFY DEVICE data word 59 bit 8 (see 7.18.7.21) is set to one and IDENTIFY DEVICE data word 59 bits 7:0 are set to zero,

then the device shall return command aborted . A successful SET MULTIPLE MODE command should precede a READ MULTIPLE command .

7.32.3 Inputs

See table 95 for the READ MULTIPLE command inputs.

Table 95 — READ MULTIPLE command inputs

Name	Description
Feature	N/A
Count	The number of logical sectors to be transferred . A value of 00h indicates that 256 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 C4h

7.32.4 Normal Outputs

See table 215.

7.32.5 Error Outputs

If an unrecoverable error occurs while the device is processing this command, then the device shall return command completion with the Error bit set to one and the LBA field set to the LBA of the logical sector where the first unrecoverable error occurred . The validity of the data transferred is indeterminate . A device may return command completion with the Error bit set to one if an Interface CRC error has occurred . See table 249 .

> NOTE 19 — There is no defined mechanism for a device to return an Interface CRC error status that may have occurred during the last data block of a PIO-in data transfer . There may be other mechanisms in which a host may verify that an Interface CRC error occurred in these cases.

7.33 READ MULTIPLE EXT - 29h, PIO Data-In

7.33.1 Feature Set

This 48-bit command is for all devices implementing the 48-bit Address feature set (see 4.4).

7.33.2 Description

The READ MULTIPLE EXT command reads the number of logical sectors specified in the Count field.

The number of logical sectors per DRQ data block is defined by the content of IDENTIFY DEVICE data word 59 (see 7.18.7.21) . The device shall interrupt for each DRQ data block transferred.

If the number of requested logical sectors is not evenly divisible by the DRQ data block count (see 7.53), as many full DRQ data blocks as possible are transferred, followed by a final, partial DRQ data block transfer.

Device errors encountered during READ MULTIPLE EXT commands are returned at the beginning of the DRQ data block or partial DRQ data block transfer.

If IDENTIFY DEVICE data word 59 bit 8 (see 7.18.7.21) is cleared to zero, and a READ MULTIPLE EXT command is received by the device, and no successful SET MULTIPLE MODE command has been processed by the device, the device shall return command aborted . A successful SET MULTIPLE MODE command should precede a READ MULTIPLE EXT command.

7.33.3 Inputs

See table 96 for the READ MULTIPLE EXT command inputs.

Table 96 — READ MULTIPLE EXT command inputs

Name	Description
Feature	Reserved
Count	The number of logical sectors to be transferred . A value of 0000h indicates that 65 536 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 29h

7.33.4 Normal Outputs

See table 227.

7.33.5 Error Outputs

If an unrecoverable error occurs while the device is processing this command, then the device shall return command completion with the Error bit set to one and the LBA field set to the LBA of the logical sector where the first unrecoverable error occurred . The validity of the data transferred is indeterminate . A device may return command completion with the Error bit set to one if an Interface CRC error has occurred . See table 261 .

> NOTE 20 — There is no defined mechanism for a device to return an Interface CRC error status that may have occurred during the last data block of a PIO-in data transfer . There may be other mechanisms in which a host may verify that an Interface CRC error occurred in these cases .

7.34 READ NATIVE MAX ADDRESS - F8h, Non-Data

7.34.1 Feature Set

This 28-bit command is for devices implementing the HPA feature set (see 4.12).

7.34.2 Description

The READ NATIVE MAX ADDRESS command returns the maximum LBA that is valid when using the SET MAX ADDRESS command.

If the native max address of a device is equal to or less than 268 435 454, a READ NATIVE MAX ADDRESS command shall return the native max address . If the native max address is greater than 268 435 454, a READ NATIVE MAX ADDRESS command shall cause the device to return a maximum value of 268 435 454.

7.34.3 Inputs

See table 97 for the READ NATIVE MAX ADDRESS command inputs.

Table 97 — READ NATIVE MAX ADDRESS command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 F8h

7.34.4 Normal Outputs

See table 224 . LBA contains the native max address.

7.34.5 Error Outputs

See table 242.

7.35 READ NATIVE MAX ADDRESS EXT - 27h, Non-Data

7.35.1 Feature Set

This 48-bit command is for devices implementing both the HPA feature set (see 4.12) and the 48-bit Address feature set (see 4.4).

7.35.2 Description

The READ NATIVE MAX ADDRESS EXT commands returns the maximum LBA that is valid when using the SET MAX ADDRESS EXT command.

7.35.3 Inputs

See table 98 for the READ NATIVE MAX ADDRESS EXT command inputs.

Table 98 — READ NATIVE MAX ADDRESS EXT command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 27h

7.35.4 Normal Outputs

See table 228 . LBA contains the native max address.

7.35.5 Error Outputs

See table 262.

7.36 READ SECTOR(S) - 20h, PIO Data-In

7.36.1 Feature Set

This 28-bit command is for ATA devices (see 4.2) and ATAPI devices (see 4.3).

7.36.2 Description

The READ SECTOR(S) command reads a maximum of 256 logical sectors as specified in the Count field . The transfer shall begin at the logical sector specified in the LBA field.

7.36.3 Inputs

See table 99 for the READ SECTOR(S) command inputs.

Table 99 — READ SECTOR(S) command inputs

Name	Description
Feature	N/A
Count	The number of logical sectors to be transferred . A value of 00h indicates that 256 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 20h

7.36.4 Outputs

7.36.5 Normal Outputs

See table 215.

7.36.6 Outputs for PACKET feature set devices

In response to this command, ATAPI shall report command aborted and place the ATAPI device signature in the LBA field (23:8), see table 221 for the list of signatures.

7.36.7 Error Outputs

The validity of the data transferred is indeterminate . A device may return command completion with the Error bit set to one if an Interface CRC error has occurred . See table 249.

> NOTE 21 — There is no defined mechanism for a device to return an Interface CRC error status that may have occurred during the last data block of a PIO-in data transfer . There may be other mechanisms in which a host may verify that an Interface CRC error occurred in these cases.

7.37 READ SECTOR(S) EXT - 24h, PIO Data-In

7.37.1 Feature Set

This 48-bit command is for devices implementing the 48-bit Address feature set (see 4.4).

7.37.2 Description

The READ SECTOR(S) EXT command reads a maximum of 65 536 logical sectors as specified in the Count field . The transfer shall begin at the logical sector specified in the LBA field.

7.37.3 Inputs

See table 100 for the READ SECTOR(S) EXT command inputs.

Table 100 — READ SECTOR(S) EXT command inputs

Name	Description
Feature	Reserved
Count	The number of logical sectors to be transferred . A value of 0000h indicates that 65 536 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit** **Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 24h

7.37.4 Normal Outputs

See table 227.

7.37.5 Error Outputs

The validity of the data transferred is indeterminate . A device may return command completion with the Error bit set to one if an Interface CRC error has occurred . See table 261 .

> NOTE 22 — There is no defined mechanism for a device to return an Interface CRC error status that may have occurred during the last data block of a PIO-in data transfer . There may be other mechanisms in which a host may verify that an Interface CRC error occurred in these cases.

7.38 READ STREAM DMA EXT - 2Ah, DMA

7.38.1 Feature Set

This 48-bit command is for devices that implement the Streaming feature set (see 4.26).

7.38.2 Description

The READ STREAM DMA EXT command provides a method for a host to read data within an allotted time . This command allows the host to specify that additional actions are to be performed by the device prior to the completion of the command.

7.38.3 Inputs

7.38.3.1 Inputs Overview

See table 101 for the READ STREAM DMA EXT command inputs.

Table 101 — READ STREAM DMA EXT command inputs

Name	Description
Feature	**Bit Description** 15:8 Command Completion Time Limit (CCTL) - See 7.38.3.2 7 Obsolete 6 Read Continuous (RC) - See 7.38.3.3 5 Not Sequential (NS) – See 7.38.3.4 4 Obsolete 3 Reserved 2:0 Stream ID – See 7.38.3.5
Count	The number of logical sectors to be transferred . A value of 0000h indicates that 65 536 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 2Ah

7.38.3.2 Command Completion Time Limit (CCTL)

the CCTL field specifies the time allowed for the device to process the command before reporting command completion.

If the CCTL field is not set to zero, then the device shall report command completion within (CCTL * (IDENTIFY DEVICE data words 98..99 (see 7.18.7.52)) microseconds . The device shall measure the time before reporting command completion from command acceptance.

If the CCTL field is set to zero, and the Default CCTL field was not set to zero in the most recent CONFIGURE STREAM command (see 7.9) for the Stream ID, then the device shall report command completion within the time specified by the Default CCTL field (see 7.9.3.4).

If the CCTL field is set to zero, and the Default CCTL field was set to zero in the most recent CONFIGURE STREAM command (see 7.9) for the Stream ID, or the CCTL field is set to zero and no previous CONFIGURE STREAM command was used to specify a Default CCTL for this Stream ID, then the result is vendor specific.

7.38.3.3 Read Continuous (RC)

If the RC bit is set to one, then:

    a)   the device shall not stop processing the command due to errors associated with reading the media;
    b)   if an error occurs during data transfer, while reading data from the media before command completion, before the amount of time allowed for command completion based on the setting of the CCTL field (see 7.38.3.2), or the Default CCTL field (see 7.9.3) is reached, then the device:
        1)   shall continue to transfer the amount of data requested;
        2)   may continue reading data from the media;
        3)   shall report command completion after all data for the command has been transferred; and
        4)   shall save the error information in the Read Streaming Error log;
        or
    c)   if the amount of time allowed for command completion based on the setting of the CCTL field (see 7.38.3.2) or the Default CCTL field (see 7.9.3) is reached, then the device:
        1)   shall stop processing the command;
        2)   shall report command completion; and
        3)   shall set the Command Completion Time Out bit in the Read Streaming Error log to one.

If the RC bit is cleared to zero and an error occurs, then the device:

    a)   may continue transferring data; and
    b)   shall report command completion after the data transfer has been completed.

7.38.3.4 Not Sequential (NS)

If the NS bit is set to one, then the next READ STREAM command with the same Stream ID may not be sequential in the LBA space . Any read of the device media or internal device buffer management as a result of the state of the NS bit is vendor specific.

7.38.3.5 Stream ID

The Stream ID field specifies the stream to be read . The device shall operate according to the parameters specified by the most recent successful CONFIGURE STREAM command specifying this Stream ID.

7.38.4 Normal Outputs

See table 220 for the definition of Normal Outputs.

7.38.5 Error Outputs

If:

    a)   the RC bit was set to one in the command, and
    b)   the device is able to return the amount of data requested for the command (e.g., an error occurred while reading from the media),

then the device shall set the Stream Error bit to one and clear the Error bit to zero.

If:

    a)   the RC bit was set to one in the command, and
    b)   the device is not able to return the amount of data requested for the command (e.g., an Interface CRC error is reported at command completion),

then the device shall clear Stream Error bit to zero and set the Error bit to one.

If:

    a)   the RC bit was cleared to zero in the command;
    b)   the CCTL field was not set to zero in the command, or the CCTL field was set to zero in the command and the Default CCTL field specified in the most recent CONFIGURE STREAM command for the Stream ID (see 7.9) was not cleared to zero; and
    c)   the time specified for command completion by the CCTL field (see 7.38.3.2) or the Default CCTL field (see 7.9.3) has been reached,

then the device shall clear the Stream Error bit to zero, set the Error bit to one, and set:

    a)   the Command Completion Timeout bit to one; or
    b)   the Abort bit to one.

If:

    a)   the RC bit was cleared to zero in the command;
    b)   the CCTL field was set to zero in the command; and
    c)   the Default CCTL field was set to zero in the most recent CONFIGURE STREAM command for the Stream ID (see 7.9),

then the device shall clear the Stream Error bit to zero, set the Error bit to one, Interface CRC bit to one, ID Not Found bit to one, and/or Abort bit to one (i.e., indicating the error type).

The validity of the data transferred is indeterminate . See table 250.

7.39 READ STREAM EXT - 2Bh, PIO Data-In

7.39.1 Feature Set

This 48-bit command is for devices that implement the Streaming feature set (see 4.26).

7.39.2 Description

See 7.38.2.

7.39.3 Inputs

See table 102 for the READ STREAM EXT command inputs.

Table 102 — READ STREAM EXT command inputs

Name	Description
Feature	**Bit Description** 15:8 Command Completion Time Limit (CCTL) - See 7.38.3.2 7 Obsolete 6 Read Continuous (RC) - See 7.38.3.3 5 Not Sequential (NS) – See 7.38.3.4 4 Obsolete 3 Reserved 2:0 Stream ID – See 7.38.3.5
Count	The number of logical sectors to be transferred . A value of 0000h indicates that 65 536 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 2Bh

7.39.4 Normal Outputs

See 7.38.4.

7.39.5 Error Outputs

See 7.38.5.

7.40 READ VERIFY SECTOR(S) - 40h, Non-Data

7.40.1 Feature Set

This 28-bit command is for ATA devices (see 4.2).

7.40.2 Description

The READ VERIFY SECTOR(S) command verifies a maximum of 256 logical sectors as specified in the Count field, without transferring data to the application client . The device shall begin verifying at the logical sector specified in the LBA field . The device shall read the data from the non-volatile media and verify that there are no errors.

7.40.3 Inputs

See table 103 for the READ VERIFY SECTOR(S) command inputs.

Table 103 — READ VERIFY SECTOR(S) command inputs

Name	Description
Feature	N/A
Count	The number of logical sectors to be verified . A value of 00h indicates that 256 logical sectors are to be verified
LBA	LBA of first logical sector to be verified
Device	**Bit** **Description** 7:5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 40h

7.40.4 Normal Outputs

See table 215.

7.40.5 Error Outputs

See table 249.

7.41 READ VERIFY SECTOR(S) EXT - 42h, Non-Data

7.41.1 Feature Set

This 48-bit command is for devices implementing the 48-bit Address feature set (see 4.4).

7.41.2 Description

The READ VERIFY SECTOR(S) EXT command verifies a maximum of 65 536 logical sectors as specified in the Count field, without transferring data to the application client . The device shall begin verifying at the logical sector specified in the LBA field . The device shall read the data from the non-volatile media and verify that there are no errors.

7.41.3 Inputs

See table 104 for the READ VERIFY SECTOR(S) EXT command inputs.

Table 104 — READ VERIFY SECTOR(S) EXT command inputs

Name	Description
Feature	Reserved
Count	The number of logical sectors to be verified . A value of 0000h indicates that 65 536 logical sectors are to be verified
LBA	LBA of first logical sector to be verified
Device	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 42h

7.41.4 Normal Outputs

See table 227.

7.41.5 Error Outputs

See table 261.

7.42 REQUEST SENSE DATA EXT - 0Bh, Non-Data

7.42.1 Feature Set

This 48-bit command is for devices implementing the Sense Data Reporting feature set (see 4.24).

7.42.2 Description

The REQUEST SENSE DATA EXT command allows the reporting of the most recent sense data from the device.

7.42.3 Inputs

See table 105 for the REQUEST SENSE DATA EXT command inputs.

Table 105 — REQUEST SENSE DATA EXT command inputs

Name	Description
Feature	Reserved
Count	Reserved
LBA	Reserved
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 0Bh

7.42.4 Normal Outputs

When sense data is available, the sense key, additional sense code, and additional sense code qualifier fields shall be set to values that are defined in the SPC-4 standard . Otherwise, the sense key, additional sense code, and additional sense code qualifier shall be cleared to zero.

See table 233.

7.42.5 Error Outputs

See table 239.

7.43 Sanitize Device

7.43.1 Sanitize Device Overview

Individual Sanitize Device commands are identified by the value placed in the Feature field . Table 106 shows these Feature field values.

Table 106 — Sanitize Device Feature Field Values

Value	Command
0000h	SANITIZE STATUS EXT (see 7.43.6)
0001h..0010h	Reserved
11h	CRYPTO SCRAMBLE EXT (see 7.43.3)
12h	BLOCK ERASE EXT (see 7.43.2)
13h	Reserved
14h	OVERWRITE EXT (see 7.43.4)
0015h..001Fh	Reserved
0020h	SANITIZE FREEZE LOCK EXT (see 7.43.5)
0021h..FFFh	

7.43.2 BLOCK ERASE EXT – B4h/0012h, Non-Data

7.43.2.1 Feature Set

This 48-bit command is for devices that implement the Sanitize Device feature set (see 4.21).

7.43.2.2 Description

The BLOCK ERASE EXT command shall start a sanitize operation which shall cause block erase operations on all user data . The BLOCK ERASE EXT command shall remove user data held in caches and pin setting attributes (see 4.17).

The BLOCK ERASE EXT command shall only be reported as supported if the internal media supports block erase operations.

After the block erase method has been successfully applied, the contents of the user data area are indeterminate.

The BLOCK ERASE EXT command shall only be processed if:

  a) the Sanitize Device feature set is supported;
  b) the BLOCK ERASE EXT command is supported; and
  c) the device is in the Sanitize Idle state, the Sanitize Operation Failed state, or the Sanitize Operation Succeeded state.

7.43.2.3 Inputs

7.43.2.3.1 Overview

See table 107 for the BLOCK ERASE EXT command inputs.

Table 107 — BLOCK ERASE EXT command inputs

Name	Description
Feature	0012h
Count	**Bit Description** 15:5 Reserved 4 Failure Mode (see 7.43.2.3.2) 3:0 Reserved
LBA	**Bit Description** 47:32 Reserved 31:0 426B_4572h
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B4h

7.43.2.3.2 Failure Mode

If the Failure Mode bit is set to one, then the device may exit the Sanitize Operation Failed state with successful processing of a SANITIZE STATUS EXT command . If the Failure Mode bit is cleared to zero, then the Sanitize Operation Failed state shall only allow additional Sanitize Operations.

7.43.2.4 Normal Outputs

See table 234.

7.43.2.5 Error Output

The Abort bit shall be set to one if a SANITIZE DEVICE FREEZE LOCK EXT command has successfully completed since the last power cycle.

See table 273.

7.43.3 CRYPTO SCRAMBLE EXT – B4h/0011h, Non-Data

7.43.3.1 Feature Set

This 48-bit command is for devices that implement the Sanitize Device feature set (see 4.21).

7.43.3.2 Description

The CRYPTO SCRAMBLE EXT command shall start a sanitize operation which shall change the internal encryption keys that are used for user data . The CRYPTO SCRAMBLE EXT command shall remove user data held in caches and pin setting attributes (see 4.17).

The CRYPTO SCRAMBLE EXT command shall only be reported as supported if all user data is affected by changing internal encryption keys.

After a successful cryptographic scramble, the contents of the user data area may be indeterminate.

The CRYPTO SCRAMBLE EXT command shall only be processed if:

    a) the Sanitize Device feature set is supported; and
    b) the device is in the Sanitize Idle state, the Sanitize Operation Failed state, or the Sanitize Operation Succeeded state.

7.43.3.3 Inputs

See table 108 for the CRYPTO SCRAMBLE EXT command inputs.

Table 108 — CRYPTO SCRAMBLE EXT command inputs

Name	Description
Feature	0011h
Count	**Bit Description** 15:5 Reserved 4 Failure Mode (see 7.43.2.3.2) 3:0 Reserved
LBA	**Bit Description** 47:32 Reserved 31:0 4372_7970h
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B4h

7.43.3.4 Normal Outputs

See table 234.

7.43.3.5 Error Output

The Abort bit shall be set to one if a SANITIZE DEVICE FREEZE LOCK EXT command has successfully completed since the last power cycle.

See table 273.

7.43.4 OVERWRITE EXT – B4h/0014h, Non-Data

7.43.4.1 Feature Set

This 48-bit command is for devices that implement the Sanitize Device feature set (see 4.21).

7.43.4.2 Description

The OVERWRITE EXT command shall start a sanitize operation which fills the user data area with a four byte pattern passed in the LBA field of the command . Parameters for the OVERWRITE EXT command include a count for multiple overwrites and the option to invert the four byte pattern between consecutive overwrite passes . The OVERWRITE EXT command shall remove user data held in caches and pin setting attributes (see 4.17).

After the overwrite method has been successfully applied, affected data blocks shall be readable without error.

The OVERWRITE EXT command shall only be processed if:

a) the Sanitize Device feature set is supported; and
b) the device is in the Sanitize Idle state, the Sanitize Operation Failed state, or the Sanitize Operation Succeeded state.

7.43.4.3 Inputs

See table 109 for the OVERWRITE EXT command inputs.

Table 109 — OVERWRITE EXT command inputs

Name	Description
Feature	0014h
Count	**Bit Description** 15:8 Reserved 7 Invert pattern between overwrite operations 6:5 Reserved 4 Failure Mode (see 7.43.2.3.2) 3:0 Count of OVERWRITE operations, a count of zero requests sixteen overwrites
LBA	**Bit Description** 47:32 4F57h 31:0 Overwrite pattern
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B4h

7.43.4.4 Normal Outputs

See table 234.

7.43.4.5 Error Output

The Abort bit shall be set to one if a SANITIZE DEVICE FREEZE LOCK EXT command has successfully completed since the last power cycle.

See table 273.

7.43.5 SANITIZE FREEZE LOCK EXT – B4h/0020h, Non-Data

7.43.5.1 Feature Set

This 48-bit command is for devices that implement the Sanitize Device feature set (see 4.21).

7.43.5.2 Description

The SANITIZE FREEZE LOCK EXT command shall set the device to the Sanitize Frozen state . After command completion all Sanitize commands other than SANITIZE STATUS EXT command shall return command aborted . Sanitize Frozen state shall be disabled by power-off or hardware reset.

7.43.5.3 Inputs

See table 110 for the SANITIZE FREEZE LOCK EXT command inputs.

Table 110 — SANITIZE FREEZE LOCK EXT command inputs

Name	Description
Feature	0020h
Count	Reserved
LBA	**Bit** **Description** 47:32 Reserved 31:0 4672_4C6Bh
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B4h

7.43.5.4 Normal Outputs

See table 234.

7.43.5.5 Error Output

See table 273.

7.43.6 SANITIZE STATUS EXT – B4h/0000h, Non-Data

7.43.6.1 Feature Set

This 48-bit command is for devices that implement the Sanitize Device feature set (see 4.21).

7.43.6.2 Description

The SANITIZE STATUS EXT command may be processed at any phase in the Sanitize Device sequence.

7.43.6.3 Inputs

7.43.6.3.1 Overview

See table 111 for the SANITIZE STATUS EXT command inputs.

Table 111 — SANITIZE STATUS EXT command inputs

Name	Description
Feature	0000h
Count	
	Bit Description
	15:1 Reserved
	0 Clear Sanitize Operation Failed
LBA	Reserved
Device	
	Bit Description
	7 Obsolete
	6 N/A
	5 Obsolete
	4 Transport Dependent - See 6.2.12
	3:0 Reserved
Command	7:0 B4h

7.43.6.3.2 Clear Sanitize Operation Failed

If in a Sanitize Operation

  a) the Failure Mode bit was set to one in the Sanitize Device command that caused the Sanitize Operation;
  b) the Sanitize Operation failed; and
  c) the Clear Sanitize Operation Failed bit is set to one in the SANITIZE STATUS EXT command,

then the Sanitize state machine shall transition from the Sanitize Failed state to the Sanitize Idle state.

If Clear Sanitize Operation Failed bit is set to one in the SANITIZE STATUS EXT command, and the Failure Mode bit was set to zero in the Sanitize Device command that caused the Sanitize Operation, the SANITIZE STATUS EXT command shall return command aborted.

7.43.6.4 Normal Outputs

See table 234.

7.43.6.5 Error Output

After the Sanitize operation has completed, if any physical sector that is available to be allocated for user data was not successfully sanitized, then this command shall return the Abort bit set to one . See table 273.

7.44 SECURITY DISABLE PASSWORD - F6h, PIO Data-Out

7.44.1 Feature Set

This 28-bit command is for devices that implement the Security feature set (see 4.22).

7.44.2 Description

The SECURITY DISABLE PASSWORD command transfers 512 bytes of data from the host . Table 113 defines the content of this information.

If the password selected by word 0 (see table 113) matches the password previously saved by the device, then the device shall disable the User password, and return the device to the SEC1 state (see figure 16).

This command shall not change the Master password or the Master Password Identifier (see 4.22.11).

If security is disabled, then:

  a) if the Identifier bit is cleared to zero (i.e., compare User password), then the device shall return command aborted; or
  b) if the Identifier bit is set to one (i.e., compare Master password), then the device may compare the password supplied with the stored Master password.

If security is enabled and the Master Password Capability bit (see 4.22.3) is cleared to zero (i.e., High), then:

  a) if the Identifier bit is set to one (i.e., compare Master password), then the password supplied shall be compared with the stored Master password; or
  b) if the Identifier bit is cleared to zero (i.e., compare User password), then the password supplied shall be compared with the stored User password.

If security is enabled and the Master Password Capability bit (see 4.22.3) is set to one (i.e., Maximum), then:

  a) if the Identifier bit is set to one (i.e., compare Master password), then the device shall return command aborted, even if the supplied Master password is valid; or
  b) if the Identifier bit is cleared to zero (i.e., compare User password), then the password supplied shall be compared with the stored User password.

Upon successful completion of this command, fields in IDENTIFY DEVICE data or the IDENTIFY PACKET DEVICE data shall be updated as follows:

  a) word 85, bit 1 (see 7.18.7.41) shall be cleared to zero (i.e., there is no active User password);
  b) word 128, bit 1 (see 7.18.7.66) shall be equal to word 85, bit 1 (see 7.18.7.41); and
  c) word 128, bit 8 (see 7.18.7.66) shall be cleared to zero (i.e., the Master Password Capability is not Maximum).

7.44.3 Inputs

See table 112 for the SECURITY DISABLE PASSWORD command inputs.

Table 112 — SECURITY DISABLE PASSWORD command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 F6h

7.44.4 Normal Outputs

See table 215.

7.44.5 Error Outputs

The device shall return command aborted if:

a) the Security feature set is not supported;
b) security is Locked (i.e., the device is in SEC4 state (see figure 16));
c) security is Frozen (i.e., the device is in SEC2 state or SEC6 state (see figure 16)); or
d) the password received in the data for the command does not match the password previously saved by the device.

A device may return command completion with the Error bit set to one if an Interface CRC error has occurred . See table 240.

7.44.6 Output From the Host to the Device Data Structure

Table 113 — SECURITY DISABLE PASSWORD data content

Word	Description
0	Control word **Bit Field Name Description** 15:1 Reserved 0 Identifier 0=compare User password 1=compare Master password
1..16	Password (32 bytes)
17..255	Reserved

7.45 SECURITY ERASE PREPARE - F3h, Non-Data

7.45.1 Feature Set

This 28-bit command is for devices that implement the Security feature set (see 4.22).

7.45.2 Description

The SECURITY ERASE PREPARE command shall be issued immediately before the SECURITY ERASE UNIT command.

7.45.3 Inputs

See table 114 for the SECURITY ERASE PREPARE command inputs.

Table 114 — SECURITY ERASE PREPARE command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 F3h

7.45.4 Normal Outputs

See table 215.

7.45.5 Error Outputs

The Abort bit shall be set to one if the device is in Frozen mode . See table 239.

7.46 SECURITY ERASE UNIT - F4h, PIO Data-Out

7.46.1 Feature Set

This 28-bit command is for devices that implement the Security feature set (see 4.22).

7.46.2 Description

The SECURITY ERASE UNIT command transfers 512-bytes of data from the host . Table 116 defines the content of this information.

The SECURITY ERASE PREPARE command shall be completed immediately prior to the SECURITY ERASE UNIT command . If the device receives a SECURITY ERASE UNIT command and the previous command was not a successful SECURITY ERASE PREPARE command, the device shall return command aborted for the SECURITY ERASE UNIT command.

When security is disabled and the Identifier bit (see table 116) is cleared to zero (i.e.,compare User password), then the device shall return command aborted.

When security is enabled:

   a) Identifier bit (see table 116) is set to one (i.e.,compare Master password), then the password supplied shall be compared with the stored Master password; or
   b) Identifier bit (see table 116) is cleared to zero (i.e.,compare User password), then the password supplied shall be compared with the stored User password.

When Normal Erase mode (see table 116) is specified, the SECURITY ERASE UNIT command shall replace the contents of LBA 0 to the LBA reported by the larger of READ NATIVE MAX command or READ NATIVE MAX EXT command with all binary zeroes or all binary ones . If the device replaces the contents of native max address + 1 to the Maximum LBA reported in DEVICE CONFIGURATION IDENTIFY data words 3..6 (see table 39), then the device shall use the same data pattern found in LBA 0 . IDENTIFY DEVICE data word 89 (see 7.18.7.43) or IDENTIFY PACKET DEVICE data word 89 (see 7.19.6.37) gives an estimate of the time required to complete the erasure.

IDENTIFY DEVICE data word 128 bit 5 (see 7.18.7.66) or IDENTIFY PACKET DEVICE data word 128 bit 5 (see 7.19.6.51) indicates whether the mode is supported . When Enhanced Erase mode is specified, the device shall write vendor specific data patterns from LBA 0 to the Maximum LBA reported in DEVICE CONFIGURATION IDENTIFY data words 3..6 (see table 39) . In Enhanced Erase mode, all previously written user data shall be overwritten, including sectors that are no longer in use due to reallocation . IDENTIFY DEVICE data word 90 (see 7.18.7.44) or IDENTIFY PACKET DEVICE data word 90 (see 7.19.6.38) gives an estimate of the time required to complete the erasure.

On successful completion, this command shall disable Security (e.g., returns the device to SEC1 state (see figure 16)), and invalidate any existing User password . Any previously valid Master password and Master Password Identifier remains valid.

Upon successful completion, the fields in the IDENTIFY DEVICE data (see table 54) or the IDENTIFY PACKET DEVICE data (see table 65) shall be updated as follows:

   a) word 85, bit 1 shall be cleared to zero (i.e., there is no active User password);
   b) word 128, bit 1 shall be cleared to zero (i.e., there is no active User password); and
   c) word 128, bit 8 shall be cleared to zero (i.e., the Master Password Capability is set to High).

7.46.3 Inputs

See table 115 for the SECURITY ERASE UNIT command inputs.

Table 115 — SECURITY ERASE UNIT command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 F4h

7.46.4 Normal Outputs

See table 215.

7.46.5 Error Outputs

The device shall return command aborted if:

a)   this command was not immediately preceded by a SECURITY ERASE PREPARE command;
b)   Enhanced mode was requested but the device does not support that mode;
c)   the password received in the data for the command does not match the password previously saved by the device;
d)   an invalid password was specified; or
e)   if the data area is not successfully overwritten.

A device may return command completion with the Error bit set to one if an Interface CRC error has occurred . See table 240.

7.46.6 Output From the Host to the Device Data Structure

Table 116 — SECURITY ERASE UNIT data content

Word	Description

0	Control word
	
	Bit Field Name Description
	15:2 Reserved
	1 Erase mode 0=Normal Erase
	                       1=Enhanced Erase
	0 Identifier 0=Compare User password
	                      1=Compare Master password

1..16	Password (32 bytes)
17..255	Reserved

7.47 SECURITY FREEZE LOCK - F5h, Non-Data

7.47.1 Feature Set

This 28-bit command is for devices that implement the Security feature set (see 4.22).

7.47.2 Description

The SECURITY FREEZE LOCK command shall set the device to Frozen mode . After command completion any other commands that update the device Lock mode shall return command aborted . Frozen mode shall be disabled by power-off or hardware reset . If a SECURITY FREEZE LOCK command is issued when the device is in Frozen mode, the command executes and the device shall remain in Frozen mode.

See table 10 for a list of commands disabled by the SECURITY FREEZE LOCK command.

Upon successful completion, IDENTIFY DEVICE data word 128 bit 3 (see 7.18.7.66) or IDENTIFY PACKET DEVICE data word 128 bit 3 (see 7.19.6.51) shall be set to one.

7.47.3 Inputs

See table 117 for the SECURITY FREEZE LOCK command inputs.

Table 117 — SECURITY FREEZE LOCK command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 F5h

7.47.4 Normal Outputs

See table 215.

7.47.5 Error Outputs

The Abort bit shall be set to one if the device is in locked mode . See table 239.

7.48 SECURITY SET PASSWORD - F1h, PIO Data-Out

7.48.1 Feature Set

This 28-bit command is for devices that implement the Security feature set (see 4.22).

7.48.2 Description

7.48.2.1 Overview

The SECURITY SET PASSWORD command transfers 512 bytes of data from the host . Table 119 defines the content of this information . The command sets only one password at a time.

7.48.2.2 Setting the Master Password

If a Master password (see 4.22.2.3) is specified, the device shall save the supplied Master password in a non-volatile location . The Master Password Capability (see 4.22.3) shall remain unchanged . This does not cause any changes to IDENTIFY DEVICE data words 85 or 128 (see table 54) or IDENTIFY PACKET DEVICE words 85 or 128 (see table 65).

If the device supports the Master Password Identifier feature (see 4.22.11) and a valid identifier is supplied (see 4.22.11), the device shall save the identifier in a non-volatile location . This new value shall be returned in IDENTIFY DEVICE data word 92 (see 7.18.7.46) or IDENTIFY PACKET DEVICE data word 92 (see 7.19.6.40) . If the host attempts to set the Master Password Identifier to 0000h or FFFFh, then the device shall preserve the existing Master Password Identifier and return successful command completion.

If the device does not support the Master Password Identifier feature, then the device shall not:

    a)   validate the Identifier field;
    b)   change IDENTIFY DEVICE data word 92 (see 7.18.7.46);
    c)   change IDENTIFY PACKET DEVICE data word 92 (see 7.19.6.40); and
    d)   return command aborted based on the value supplied in the Master Password Identifier field (see 4.22.11).

7.48.2.3 Setting the User Password

If a User password (see 4.22.2.2) is specified, the device shall save the User password in a non-volatile location and update the Master Password Capability (see 4.22.3) . The Master Password Identifier (see 4.22.11) shall not be changed . These fields in the IDENTIFY DEVICE data (see table 54) or the IDENTIFY PACKET DEVICE data (see table 65) shall be updated as follows:

    a)   word 85, bit 1 shall be set to one (i.e., security is enabled);
    b)   word 128, bit 1 shall be set to one (i.e., security is enabled); and
    c)   word 128, bit 8 shall indicate the Master Password Capability (see 4.22.3).

7.48.3 Inputs

See table 118 for the SECURITY SET PASSWORD command inputs.

Table 118 — SECURITY SET PASSWORD command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 F1h

7.48.4 Normal Outputs

See table 215.

7.48.5 Error Outputs

If the device is locked (see 4.22.2.2) or in Frozen mode (see 4.22.4), then the device shall return command aborted . A device may return command completion with the Error bit set to one if an Interface CRC error has occurred . See table 240.

7.48.6 Output From the Host to the Device Data Structure

Table 119 — SECURITY SET PASSWORD data content

Word	Description

0	Control word
	
	Bit **Field Name** **Description**
	15:9 Reserved
	8 Master Password Capability 0=High
	                                                        1=Maximum
	7:1 Reserved
	0 Identifier 0=set User password
	                                                        1=set Master password

1..16	Password (32 bytes)
17	Master Password Identifier . This word is valid if word 0 bit 0 is set to one.
18..255	Reserved

7.49 SECURITY UNLOCK - F2h, PIO Data-Out

7.49.1 Feature Set

This 28-bit command is for devices that implement the Security feature set (see 4.22).

7.49.2 Description

The SECURITY UNLOCK command transfers 512 bytes of data from the host . Table 121 defines the content of this information.

When security is disabled and the Identifier bit (see table 121) is cleared to zero (i.e., compare User password), then the device shall return command aborted.

If security is enabled, and the Master Password Capability (see 4.22.3) is cleared to zero (i.e., High), then:

   a) if the Identifier bit is set to one (i.e., compare Master password), then the password supplied shall be compared with the stored Master password; or
   b) if the Identifier bit is cleared to zero (i.e., compare User password), then the password supplied shall be compared with the stored User password.

If security is enabled and the Master Password Capability is set to Maximum, then:

   a) if the Identifier bit is set to one (i.e., compare Master password), then the device shall return command aborted; or
   b) if the Identifier bit is cleared to zero (i.e., compare User password), then the password supplied shall be compared with the stored User password.

If the password received in the data for the command does not match the password previously saved by the device, then the device shall return command aborted and decrement the password attempt counter . When this counter reaches zero, IDENTIFY DEVICE data word 128 bit 4 (see 7.18.7.66) or IDENTIFY PACKET DEVICE data word 128 bit 4 (see 7.19.6.51) shall be set to one, and the SECURITY UNLOCK command and the SECURITY ERASE UNIT command shall return command aborted until a power-on reset or a hardware reset . SECURITY UNLOCK commands issued when the device is unlocked have no effect on the unlock counter.

Upon successful completion of this command, IDENTIFY DEVICE data word 128 bit 2 (see 7.18.7.66) or IDENTIFY PACKET DEVICE data word 128 bit 2 (see 7.19.6.51) shall be cleared to zero (i.e., the device is not in a Locked state).

7.49.3 Inputs

See table 120 for the SECURITY UNLOCK command inputs.

Table 120 — SECURITY UNLOCK command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A

Device	**Bit Description**
	  7 Obsolete
	  6 N/A
	  5 Obsolete
	  4 Transport Dependent - See 6.2.12
	3:0 Reserved

Command	7:0 F2h

7.49.4 Normal Outputs

See table 215.

7.49.5 Error Outputs

If the device is in Frozen mode (see 4.22.4) or an invalid password is supplied or the password attempt counter has decremented to zero, the device shall return command aborted.

A device may return command completion with the Error bit set to one if an Interface CRC error has occurred . See table 240.

7.49.6 Output From the Host to the Device Data Structure

Table 121 — SECURITY UNLOCK data content

Word	Description
0	Control word **Bit** **Field Name** **Description** 15:1 Reserved 0 Identifier 0=compare User password 1=compare Master password
1..16	Password (32 bytes)
17..255	Reserved

7.50 SET FEATURES - EFh, Non-Data

7.50.1 Feature Set

This 28-bit command is mandatory for ATA devices (see 4.2) and ATAPI devices (see 4.3).

7.50.2 Description

The SET FEATURES command is used by the host to establish parameters that affect the processing of certain device features . Table 122 defines these features.

After a power-on reset or a hardware reset, the settings specified by the subcommands are vendor specific unless otherwise specified in this standard . Software reset is described in the individual subcommands as needed.

Table 122 — SET FEATURES Feature field definitions (part 1 of 3)

Value	Description
00h	Reserved
01h	If the device implements the CFA feature set, then enable 8-bit PIO transfer mode (see 7.50.3); otherwise this value is reserved.
02h	Enable volatile write cache (see 7.50.4)
03h	Set transfer mode (see 7.50.5)
04h	Obsolete
05h	Enable the APM feature set (see 7.50.6)
06h	Enable the PUIS feature set (see 7.50.7)
07h	PUIS feature set device spin-up (see 7.50.8)
08h	Reserved
09h	If the device implements the CFA feature set, then this subcommand is reserved for CFA . Otherwise, this subcommand is reserved for Address Offset Reserved Area Boot Method.
0Ah	Enable CFA power mode 1 (see 7.50.9)
0Bh	Enable Write-Read-Verify feature set (see 7.50.10)
0Ch..0Fh	Reserved
10h	Enable use of SATA feature (see 7.50.16)
11h..1Fh	Reserved
20h	Reserved for TLC
21h	Reserved for TLC
22h..30h	Reserved
31h	Obsolete
32h	Reserved
33h	Obsolete
34h..40h	Reserved
41h	Enable the Free-fall Control feature set (see 7.50.15)
42h	Enable the AAM feature set (see 7.50.11)
43h	Set Maximum Host Interface Sector Times (see 7.50.12)
44h	Obsolete
45h..49h	Reserved
4Ah	Extended Power conditions (see 7.50.19)
4Bh..53h	Reserved

Table 122 — SET FEATURES Feature field definitions (part 2 of 3)

Value	Description
54h	Obsolete
55h	Disable read look-ahead feature (see 7.50.13)
56h..5Ch	Vendor Specific
5Dh..5Eh	Obsolete
5Fh	Reserved for DDT
60h..61h	Reserved
62h	Long Physical Sector Alignment Error Reporting Control (see 7.50.18)
63h..65h	Reserved
66h	Disable reverting to power-on defaults (see 7.50.14)
67h..68h	Reserved
69h	If the device implements the CFA feature set, then this subcommand is reserved for CFA; otherwise this value is reserved.
6Ah..76h	Reserved
77h	Obsolete
78h..80h	Reserved
81h	If the device implements the CFA feature set, then disable 8-bit PIO transfer mode (see 7.50.3); otherwise this value is reserved.
82h	Disable volatile write cache (see 7.50.4)
83h	Reserved
84h	Obsolete
85h	Disable the APM feature set (see 7.50.6)
86h	Disable the PUIS feature set (see 7.50.7)
87h	Reserved
88h	Obsolete
89h	If the device implements the CFA feature set, then this subcommand is reserved for CFA; otherwise this subcommand is reserved for Address Offset Reserved Area Boot Method.
8Ah	Disable CFA power mode 1 (see 7.50.9)
8Bh	Disable Write-Read-Verify feature set (see 7.50.10)
8Ch..8Fh	Reserved
90h	Disable use of SATA feature (see 7.50.16)
91h..94h	Reserved
95h	Obsolete
96h..99h	Reserved
99h	Obsolete

Table 122 — SET FEATURES Feature field definitions (part 3 of 3)

Value	Description
9Ah	Obsolete
9Bh..A9h	Reserved
AAh	Enable read look-ahead feature (see 7.50.13)
ABh	Obsolete
ACh..BAh	Reserved
BBh	Obsolete
BCh..C0h	Reserved
C1h	Disable the Free-fall Control feature set (see 7.50.15)
C2h	Disable the AAM feature set (see 7.50.11)
C3h	Enable/Disable the Sense Data Reporting feature set (see 7.50.17)
C4h..CBh	Reserved
CCh	Enable reverting to power-on defaults (see 7.50.14)
CDh..D5h	Reserved
D6h..DCh	Vendor Specific
DDh.DEh	Obsolete
DFh	Reserved for DDT
E0h	Vendor Specific
E1h..EFh	Reserved
F0h..F3h	Reserved for assignment by the CompactFlash Association
F4h..FFh	Reserved

7.50.3 Enable/disable 8-bit PIO data transfer

Subcommand codes 01h and 81h allow the host to enable or disable 8-bit PIO data transfers . CFA-APT devices shall support 8-bit PIO data transfers . All other devices shall not support 8-bit PIO data transfers . See the CFA specification for more information.

7.50.4 Enable/disable volatile write cache

Subcommand codes 02h and 82h allow the host to enable or disable volatile write cache in devices that implement volatile write cache . When the disable volatile write cache subcommand is issued, the device shall initiate the sequence to flush volatile cache to non-volatile media before command completion (see 7.16) . These subcommands may affect caching for commands in the Streaming feature set . Enable/disable write cache subcommands are mandatory when a write cache is implemented.

7.50.5 Set transfer mode

The set transfer mode subcommand is mandatory . The transfer mechanism is selected by Set Transfer Mode, subcommand code 03h, and specifying a value in the Count field . Bits (7:3) define the type of transfer and bits (2:0) encode the mode value . The selected modes may be changed by the SET FEATURES command . Table 123 shows the available transfer modes.

Table 123 — Transfer modes

Mode	Bits (7:3)	Bits (2:0)
PIO default mode	0_0000b	000b
PIO default mode, disable IORDY	0_0000b	001b
PIO flow control transfer mode	0_0001b	Mode
Retired	0_0010b	N/A
Multiword DMA mode	0_0100b	Mode
Ultra DMA mode	0_1000b	Mode
Reserved	1_0000b	N/A
Key: Mode = transfer mode number (See 7.18.7.24, 7.18.7.25, 7.18.7.42)		

If a device receives a SET FEATURES command with a Set Transfer Mode subcommand and the Count field value set to 0000_0000b, then the device shall set the default PIO mode . If the Count field is set to 0000_0001b . and the device supports disabling of IORDY (see ATA8-APT), then the device shall set the default PIO mode and disable IORDY . A device shall support all PIO modes below the highest mode supported (e.g., if PIO mode 1 is supported PIO mode 0 shall be supported).

Support of IORDY is mandatory when PIO mode 3 or above is the current mode of operation.

A device shall support all Multiword DMA modes below the highest mode supported (e.g., if Multiword DMA mode 1 is supported Multiword DMA mode 0 shall be supported).

A device shall support all Ultra DMA modes below the highest mode supported (e.g., if Ultra DMA mode 1 is supported Ultra DMA mode 0 shall be supported).

If an Ultra DMA mode is enabled any previously enabled Multiword DMA mode shall be disabled by the device . If a Multiword DMA mode is enabled any previously enabled Ultra DMA mode shall be disabled by the device.

For PATA systems using a cable assembly, the host should determine that an 80-conductor cable assembly is connecting the host with the device(s) before enabling any Ultra DMA mode greater than 2 in the device(s) (see ATA8-APT).

7.50.6 Enable/disable the APM feature set

Subcommand code 05h enables APM (see 4.5) . The APM level is a scale from the lowest power consumption setting of 01h to the maximum performance level of FEh . Table 124 shows these values.

Table 124 — APM levels

Count	Level
00h	Reserved
01h	Minimum power consumption with Standby
02h-7Fh	Intermediate power management levels with Standby
80h	Minimum power consumption without Standby
81h-FDh	Intermediate power management levels without Standby
FEh	Maximum performance
FFh	Reserved

Device performance may increase with increasing APM levels . Device power consumption may increase with increasing power management levels . The APM levels may contain discrete bands (e.g., a device may implement one APM method from 80h to A0h and a higher performance, higher power consumption method from level A1h to FEh) . APM levels 80h and higher do not permit the device to spin down to save power.

Subcommand code 85h disables APM . Subcommand 85h may not be implemented on all devices that implement SET FEATURES subcommand 05h.

7.50.7 Enable/disable the PUIS feature set

Subcommand code 06h enables the PUIS feature set (see 4.20) . When this feature set is enabled, the device shall power-up into Standby mode (i.e., the device shall be ready to receive commands but shall not spin-up) (see 4.20) . Once this feature set is enabled, it shall only be disabled by a subsequent SET FEATURES command disabling this feature set . This feature set shall not be disabled after a power-on reset, a hardware reset, or a software reset.

Subcommand code 86h disables the PUIS feature set . When this feature set is disabled, the device shall power-up into Active mode . The factory default for this feature set shall be disabled.

7.50.8 PUIS feature set device spin-up

Subcommand code 07h shall cause a device that has powered-up into Standby to go to the Active state (see 4.20 and figure 14).

7.50.9 Enable/disable CFA power mode 1

Subcommand code 0Ah causes a CFA device to transition to CFA Power Mode 1 . CFA devices may consume up to 500 mA maximum average RMS current for either 3.3 V or 5 V operation in Power Mode 1.

Subcommand 8Ah causes a CFA device to transition to CFA Power Mode 0 . CFA devices may consume up to 75 mA maximum average RMS current for 3.3 V or 100 mA maximum average RMS current for 5 V operation in Power Mode 0.

If a CFA device is in CFA Power Mode 0, then the device shall transition to CFA Power Mode 1 after processing of a power-on reset or a hardware reset.

If a CFA device is in CFA Power Mode 0 and in the Reverting to defaults enabled mode (see 7.50.14), then the device shall transition to CFA Power Mode 1 after processing of a software reset.

If a CFA device is in CFA Power Mode 0 and in the Reverting to defaults disabled mode (see 7.50.14), then the device shall not transition to CFA Power Mode 1 after processing of a software reset.

Enabling CFA Power Mode 1 does not cause a spin-up.

A device in Power Mode 0 shall accept the following commands:

    a)   IDENTIFY DEVICE;

b)   SET FEATURES (subcommand codes 0Ah and 8Ah);
c)   STANDBY;
d)   STANDBY IMMEDIATE;
e)   SLEEP;
f)   CHECK POWER MODE;
g)   EXECUTE DEVICE DIAGNOSTICS; and
h)   CFA REQUEST EXTENDED ERROR.

A device in Power Mode 0 may accept any command that the device is capable of processing within the Power Mode 0 current restrictions . Commands that require more current than specified for Power Mode 0 shall be rejected with an abort error .

7.50.10 Enable/Disable Write-Read-Verify feature set

Subcommand code 0Bh enables the Write-Read-Verify feature set.

Bits (7:0) of the LBA field in the SET FEATURES command specify the Write-Read-Verify mode . Table 125 defines the Write-Read-Verify modes.

Table 125 — Write-Read-Verify Modes

Mode	Description
00h [a]	Always enabled (i.e., the device shall perform a Write-Read-Verify for all logical sectors for all write commands).
01h [a]	The device shall perform a Write-Read-Verify on the first 65 536 logical sectors written after: a) spin-up; or b) the device completes a SET FEATURES command setting the Write-Read-Verify mode without error.
02h [a]	The number of logical sectors on which a device performs a Write-Read-Verify is vendor specific.
03h	The device shall perform a Write-Read-Verify on the first n logical sectors written by the host after: a) spin-up; or b) the device completes a SET FEATURES command setting the Write-Read-Verify mode without error. n=x * 1 024 where: x=number specified by the Count field.
04h-FFh	Reserved
[a] the Count field shall be ignored.	

Subcommand code 8Bh disables the Write-Read-Verify feature set.

A device shall set the Write-Read-Verify feature set to its factory default setting after processing of a power-on reset or a hardware reset.

If a device is in the reverting to defaults enabled mode (see 7.50.14), then the device shall set the Write-Read-Verify feature set to its factory default setting after processing of a software reset.

If a device is in the reverting to defaults disabled mode (see 7.50.14), then the device shall not change the settings of the Write-Read-Verify feature set after processing of a software reset.

7.50.11 Enable/disable the AAM feature set

Subcommand code 42h enables the AAM feature set (see 4.6) . To enable the AAM feature set, the host writes the Count field with the requested automatic acoustic management level and processes a SET FEATURES

command with subcommand code 42h . The AAM level is selected on a scale from 01h to FEh . Table 126 shows the AAM level values.

Enabling or disabling of the AAM feature set, and the current AAM level setting shall be preserved by the device across all forms of reset (i.e., power-on, hardware, and software resets).

Table 126 — AAM levels

Count	Level
00h	Vendor Specific
01h-7Fh	Retired
80h	Minimum acoustic emanation level
81h-FDh	Intermediate acoustic management levels
FEh	Maximum performance
FFh	Reserved

Device performance may increase with increasing AAM levels . Device power consumption may decrease with decreasing AAM levels . The AAM levels may contain discrete bands (e.g., a device may implement one acoustic management method from 80h to BFh and a higher performance, higher acoustic management method from level C0h to FEh).

Upon successful completion of this SET FEATURES subcommand, IDENTIFY DEVICE data word 94 bits (7:0) (see 7.18.7.48) or IDENTIFY PACKET DEVICE data word 94 bits (7:0) (see 7.19.6.42) shall be shall be updated by the device . If the command is aborted by the device, the previous AAM state shall be retained.

Subcommand code C2h disables the AAM feature set . Devices that implement SET FEATURES subcommand 42h are not required to implement subcommand C2h . If the device completes processing of this subcommand without error, then the acoustic behavior of the device shall be vendor specific, and the device shall return zeros in bits (7:0) of word 94 and bit 9 of word 86 of the IDENTIFY DEVICE or IDENTIFY PACKET DEVICE data.

Upon completion of SET FEATURES subcommands 42h and C2h, the device may update IDENTIFY DEVICE data words 96..97 and word 104 (see table 54) or IDENTIFY PACKET DEVICE data words 96..97 and word 104 (see table 65).

7.50.12 Set Maximum Host Interface Sector Times

Subcommand code 43h allows the host to inform the device of a host interface rate limitation . This information shall be used by the device to meet the Command Completion Time Limits of the commands of the Streaming feature set . To inform the device of a host interface rate limitation, the host writes the value of its Typical PIO Host Interface Sector Time (see table 127) to the Count field (7:0) and LBA (7:0) field and writes the value of its Typical DMA Host Interface Sector Time (see table 127) to the LBA (23:8) field . The Typical Host Interface Sector Times (see table 127) have the same units as IDENTITY DEVICE data word 96 (see 7.18.7.50) for DMA and IDENTITY DEVICE data word 104 (see 7.18.7.54) for PIO . A value of zero indicates that the host interface shall be capable of transferring data at the maximum rate allowed by the selected transfer mode . The Typical PIO Mode Host Interface Sector Time includes the host's interrupt service time.

Upon completion of SET FEATURES subcommand 43h, the device may adjust IDENTIFY DEVICE data words 96..97 (see 7.18.7.50 and 7.18.7.51) to allow for the specified host interface sector time . See table 127 for the Count field and LBA field definitions.

Table 127 — Maximum Host Interface Sector Times

Field	Bits	Description
Count	15:8	Reserved
	7:0	Typical PIO Mode Host Interface Sector Time (7:0)
LBA	47:24	Reserved
	23:8	Typical DMA Mode Host Interface Sector Time
	7:0	Typical PIO Mode Host Interface Sector Time (15:8)

7.50.13 Enable/disable read look-ahead

Subcommand codes AAh and 55h enables or disables read look-ahead . Error recovery performed by the device is vendor specific.

7.50.14 Enable/disable reverting to defaults

Subcommand codes CCh and 66h enables or disables the reverting to defaults mode.

A device is in the reverting to defaults disabled mode after completing a SET FEATURES command with subcommand code 66h without error . A device should enter the reverting to defaults disabled mode after power-on or hardware reset . A device in the reverting to defaults disabled mode, shall not reset parameters to their default power-on values during the processing of a software reset.

A device is in the Reverting to defaults enabled mode after the device completes a SET FEATURES command with subcommand CCh without error . A device in the reverting to defaults enabled mode may reset parameters to their default power-on values during the processing of a software reset.

7.50.15 Enable/Disable the Free-fall Control feature set

Subcommand codes 41h and C1h allow the host to enable or disable the Free-fall Control feature set (see 4.10) . To enable the Free-fall Control feature set, the host writes the Count field with the requested free-fall control sensitivity setting and processes a SET FEATURES command with subcommand code 41h.

The sensitivity is selected on a scale from 00h to FFh . A value of zero selects the device vendor's recommended setting . Other values are vendor specific . The higher the sensitivity value, the more sensitive the device is to changes in acceleration.

Enabling or disabling of the Free-fall Control feature set, and the current free-fall sensitivity setting shall be preserved by the device across all forms of reset (i.e., power-on, hardware, and software resets).

7.50.16 Enable/Disable SATA feature

7.50.16.1 Overview

Subcommand codes 10h and 90h allow the host to enable or disable Serial ATA features . The Count field contains the specific Serial ATA feature to enable or disable . The specific Serial ATA features in which SET FEATURES is applicable are defined in table 128.

Table 128 — SATA Features

Count	Description
00h	Reserved for Serial ATA
01h	Non-zero Buffer Offsets
02h	DMA Setup FIS Auto-Activate optimization
03h	Device-initiated interface power state transitions
04h	Guaranteed In-Order Data Delivery
05h	Asynchronous Notification
06h	Software Settings Preservation
07h-FFh	Reserved for Serial ATA

7.50.16.2 Enable/Disable Non-Zero Buffer Offsets

A Count field value of 01h is used to enable or disable non-zero buffer offsets for commands in the NCQ feature set (see 4.16) . By default, non-zero buffer offsets are disabled . The enable/disable state for non-zero offsets shall be preserved across software reset . The enable/disable state for non-zero offsets shall be reset to its default state upon COMRESET . See SATA 2.6 for more information.

7.50.16.3 Enable/Disable DMA Setup FIS Auto-Activate Optimization

A Count field value of 02h is used to enable or disable DMA Setup FIS Auto-Activate optimization . See SATA 2.6 for more information . The enable/disable state for the auto-activate optimization shall be preserved across software reset . The enable/disable state for the auto-activate optimization shall be reset to its default state upon COMRESET.

7.50.16.4 Enable/Disable Device-Initiated Interface Power State Transitions

A Count field value of 03h is used to enable or disable device initiation of interface power state transitions . By default, the device is not permitted to initiate interface power state transitions . See SATA 2.6 for more information . The enable/disable state for device initiated power management shall persist across software reset . The enable/disable state shall be reset to its default disabled state upon COMRESET.

If device initiated interface power management is enabled, the device shall not attempt to initiate an interface power state transition between reset and the delivery of the device reset signature (see table 221).

7.50.16.5 Enable/Disable Guaranteed in-Order Data Delivery

A Count field value of 04h is used to enable or disable guaranteed in-order data delivery for commands in the NCQ feature set (see 4.16) . This setting is only valid when non-zero buffer offsets are enabled . By default, guaranteed in-order data delivery is disabled . See SATA 2.6 for more information . The enable/disable state for guaranteed in-order data delivery shall be preserved across software reset . The enable/disable state for guaranteed in-order data delivery shall be reset to its default state upon COMRESET.

7.50.16.6 Enable/Disable Asynchronous Notification

For ATAPI devices, a Count field value of 05h is used to enable or disable asynchronous notification . By default, asynchronous notification is disabled . See SATA 2.6 for more information . The enable/disable state for asynchronous notification shall be preserved across software reset . The enable/disable state for asynchronous notification shall be reset to its default state upon COMRESET.

7.50.16.7 Enable/Disable Software Settings Preservation

See table 16 for a list of the preserved feature sets and settings . A Count field value of 06h is used to enable or disable software settings preservation . By default, if the device supports software settings preservation the feature is enabled when it processes a power-on reset . The enable/disable state for software settings preservation shall persist across software reset . The enable/disable state for software settings preservation shall be reset to its default state upon COMRESET . The host may disable software settings preservation in order to cause software settings to revert to their power-on default state when the device receives a COMRESET.

7.50.17 Enable/Disable the Sense Data Reporting feature set

Subcommand code C3h allows the application client to enable the Sense Data Reporting feature set (see 4.24) by issuing this subcommand with bit zero of the count field set to one.

The Sense Data Reporting feature set shall be disabled by issuing this subcommand with bit zero of the Count field cleared to zero.

All other sub-command specific fields are reserved.

7.50.18 Long Physical Sector Alignment Error Reporting Control

Subcommand code 62h allows the application client to control the reporting of errors associated with the LPS feature set (see 4.14) . IDENTIFY DEVICE data word 69 bit 13 (see 7.18.7.30) indicates that Long Physical Sector Alignment Error Reporting is supported . IDENTIFY DEVICE data word 49 bits (1:0) (see 7.18.7.17) indicate the current Long Physical Sector Alignment Error Reporting setting.

If the Count field is cleared to zero, then the device shall disable Alignment Error reporting;

If the Count field is set to one, then the device shall process the command and shall report an Alignment (see 6.2.2) when the application client issues a write command in which:

   a)   the first byte of data transfer does not begin at the first byte of a physical sector (see 7.18.7.76); or
   b)   the last byte of data transfer does not end at the last byte of a physical sector (see 7.18.7.76).

If the Count field is set to two, then the device shall report an Alignment Error (see 6.2.2) and Command Aborted, leaving the condition of the data unknown, if the application client issues a write command in which:

   a)   the first byte of data transfer does not begin at the first byte of a physical sector (see 7.18.7.76); or
   b)   the last byte of data transfer does not end at the last byte of a physical sector (see 7.18.7.76).

If the Count field is set to 03h..FFh, the device shall report command aborted.

If Long Physical Sector Alignment Error Reporting Control is supported, then the device shall support the Long Physical Sector Mis-alignment log (see A.11).

This setting shall be preserved across all resets.

7.50.19 Extended power conditions

7.50.19.1 Overview

Subcommand code 4Ah enables, disables, and configures the use of the Extended Power Conditions feature set (see 4.9) . If the EPC feature is not supported, then the device shall return command aborted . Table 129 describes the EPC subcommands and table 130 describes the power condition IDs.

Table 129 — Extended Power Conditions Subcommands

EPC Subcommand	Description
0h	Restore Power Condition Settings (see 7.50.19.2)
1h	Go To Power Condition (see 7.50.19.3)
2h	Set Power Condition Timer (see 7.50.19.4)
3h	Set Power Condition State (see 7.50.19.5)
4h..Fh	Reserved

Table 130 — Power Condition IDs

Power Condition ID	Power Condition Name	Description
00h	Standby_z	A substate of the PM2:Standby state [a]
01h	Standby_y	A substate of the PM2:Standby state [a]
02h..80h		Reserved
81h	Idle_a	A substate of the PM1:Idle state [a]
82h	Idle_b	A substate of the PM1:Idle state [a]
83h	Idle_c	A substate of the PM1:Idle state [a]
84h..FEh		Reserved
FFh	All	All EPC power conditions
[a] See 4.19.4 for the description of the power states.		

7.50.19.2 Restore Power Condition Settings subcommand

7.50.19.2.1 Description

On successful completion of this EPC subcommand, the device shall update the Power Conditions log (see A.8) for the selected Power Condition ID(s) as follows:

1) if Default is set to one, then:
   A) copy the Default Timer Settings field (see A.8) to the Current Timer Settings field (see A.8); and
   B) copy the Default Timer Enabled field (see A.8) to the Current Timer Enabled field (see A.8);
2) if Default is cleared to zero, then:
   A) copy the Saved Timer Settings field (see A.8) to the Current Timer Settings field (see A.8); and
   B) copy the Saved Timer Enabled field (see A.8) to the Current Timer Enabled field (see A.8);

   and

3) if Save is set to one and the power condition is saveable, then:
   A) copy the Current Timer Settings field (see A.8) to the Saved Timer Settings field (see A.8); and
   B) copy the Current Timer Enabled field (see A.8) to the Saved Timer Enabled field (see A.8).

7.50.19.2.2 Inputs

See table 131 for the SET FEATURES command inputs.

Table 131 — SET FEATURES command inputs

Name	Description
Feature	4Ah (i.e., Extended power conditions)
Count	Power Condition (see table 130)

LBA	**Bit Description**
	
	27:7 Reserved
	
	6 Default
	        1 = Restore from Default settings
	        0 = Restore from Saved settings
	
	5 Reserved
	
	4 Save
	        1 = Save settings on completion
	        0 = Do not save settings on completion
	
	3:0 0h (i.e., Restore Power Condition subcommand (see table 129))

Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 EFh

7.50.19.2.3 Normal Outputs

See table 215.

7.50.19.2.4 Error Outputs

If any selected Power Condition:

    a)   is not supported;
    b)   is not changeable; or
    c)   if Save is set to one and any selected power condition is not saveable,

then the device shall return command aborted . See table 239.

7.50.19.3 Go To Power Condition subcommand

7.50.19.3.1 Description

On successful completion of this EPC subcommand, the device shall:

1) stop all enabled EPC timers (see 4.9.3);
2) enter the selected EPC power condition (see 4.9.2) after command completion of the SET FEATURES command without having to wait for any timers to expire; and
3) the device shall remain in the selected power condition until the device processes the next command or reset.

7.50.19.3.2 Inputs

See table 132 for the SET FEATURES command inputs.

Table 132 — SET FEATURES command inputs

Name	Description
Feature	4Ah (i.e., Extended power conditions)
Count	Power Condition (see table 130)
LBA	**Bit Description** 27:4 Reserved 3:0 1h (i.e., Go To Power Condition subcommand (see table 129))
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 EFh

7.50.19.3.3 Normal Outputs

See table 215.

7.50.19.3.4 Error Outputs

If the Power condition ID is FFh, a reserved value, or is not supported, then the device shall return command aborted . See table 239.

7.50.19.4 Set Power Condition Timer subcommand

7.50.19.4.1 Description

On successful completion of this EPC subcommand, the device shall update the Power Conditions log (see A.8) for the selected and supported Power Condition (see 4.9.2) as follows:

1) copy the Timer field to the Current Timer Settings field;
2) if Enable is set to one and the Timer field is non-zero, then enable the Current Timer;
3) if Enable is set to one and the Timer field is zero, then disable the Current Timer;
4) if Enable is cleared to zero, then disable the Current Timer; and
5) if Save is set to one and the Power Condition settings are saveable, then:
    A) copy the Current Timer Settings field to the Saved Timer Settings field; and
    B) copy the Current Timer Enabled field to the Saved Timer Enabled field.

7.50.19.4.2 Inputs

See table 133 for the SET FEATURES command inputs.

Table 133 — SET FEATURES command inputs

Name	Description
Feature	4Ah (i.e., Extended power conditions)
Count	Power Condition (see table 130)

LBA	**Bit Description**
	
	27:24 Reserved
	
	23:8 Timer (15:0) (see 7.50.19.4.3)
	
	7 Timer Units (see 7.50.19.4.4)
	
	6 Reserved
	
	5 Enable
	       1 = Enable the selected power condition
	       0 = Disable the selected power condition
	
	4 Save
	       1 = Save settings on completion
	       0 = Do not save settings on completion
	
	3:0 2h (i.e., Set Power Condition Timer subcommand (see table 129))

Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 EFh

7.50.19.4.3 Timer (15:0)

If the new timer value is greater than the maximum value setting, then the device may set the value to the maximum setting . If the new timer value is less than the minimum setting, then the device may set the value to the minimum setting.

7.50.19.4.4 Timer Units

If the Timer Units bit is cleared to zero, then the Timer (15:0) shall be specified in units of 100 milliseconds.

If the Timer Units bit is set to one, then the Timer (15:0) shall be specified in units of 1 minute.

7.50.19.4.5 Normal Outputs

See table 215.

7.50.19.4.6 Error Outputs

The device shall return command aborted If:

a) the new timer value is:
   A) less than the maximum setting;
   B) greater than the minimum setting; and
   C) not supported by the device;
b) the Power Condition field is invalid;
c) the power condition is not changeable or not supported;
d) the Save bit is set to one and the selected power condition is not saveable;
e) the new time value is greater than the maximum setting (see A.8) and the device did not set the timer to the maximum setting; or
f) the new time value is less than the minimum setting (see A.8) and the device did not set the timer to the minimum setting.

If command aborted is returned, then the device shall make no modifications to the power condition settings . See table 239.

7.50.19.5 Set Power Condition State subcommand

7.50.19.5.1 Description

On successful completion of this EPC subcommand, the device shall update the Power Conditions log (see A.8) for the Power Condition(s) as follows:

1) If the Enable bit (see A.8) is set to one, then enable the Current Timer (see A.8); otherwise disable the Current Timer; and

2) If the Save bit (see A.8) is set to one, then copy the Current Timer Enabled field to the Saved Timer Enabled field.

7.50.19.5.2 Inputs

See table 134 for the SET FEATURES command inputs.

Table 134 — SET FEATURES command inputs

Name	Description
Feature	4Ah (i.e., Extended power conditions)
Count	Power Condition (see table 130)

LBA	**Bit Description**
	
	27:6 Reserved
	
	5 Enable
	    1 = Enable the selected power condition
	    0 = Disable the selected power condition
	
	4 Save
	    1 = Save settings on completion
	    0 = Do not save settings on completion
	
	3:0 3h (i.e., Set Power Condition State subcommand (see table 129))

Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 EFh

7.50.19.5.3 Normal Outputs

See table 215.

7.50.19.5.4 Error Outputs

If the Power Condition is invalid, not changeable, or not supported then the device shall return command aborted . If the Save bit is set to one and the selected power condition is not saveable, then the device shall return command aborted . If command aborted is returned, then the device shall make no modifications to the power condition settings . See table 239.

7.50.20 Inputs

See table 135 for the SET FEATURES command inputs.

Table 135 — SET FEATURES command inputs

Name	Description
Feature	Subcommand Code - See table 122
Count	Subcommand specific
LBA	Subcommand specific
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 EFh

7.50.21 Normal Outputs

See table 215.

7.50.22 Error Outputs

The Abort bit shall be set to one if any subcommand input value is not supported or is invalid . See table 239.

7.51 SET MAX

7.51.1 SET MAX Overview

Individual SET MAX commands are identified by the value placed in the Feature field . Table 136 shows these Feature field values.

Table 136 — SET MAX Feature field values

Value	Command
00h	Obsolete
01h	SET MAX SET PASSWORD (see 7.51.5)
02h	SET MAX LOCK (see 7.51.4)
03h	SET MAX UNLOCK (see 7.51.7)
04h	SET MAX FREEZE LOCK (see 7.51.3)
05h	SET MAX SET PASSWORD DMA (see 7.51.6)
06h	SET MAX UNLOCK DMA (see 7.51.8)
07h..FFh	Reserved

7.51.2 SET MAX ADDRESS - F9h, Non-Data

7.51.2.1 Feature Set

This 28-bit command is for devices that implement the HPA feature set (see 4.12).

7.51.2.2 Description

The SET MAX ADDRESS command shall cause all read and write access attempts to an LBA greater than the LBA specified by the successful SET MAX ADDRESS command to be rejected with the ID Not Found bit (see 6.3.6) set to one . IDENTIFY DEVICE data words 60..61 (see 7.18.7.22) shall reflect the maximum LBA set with this command.

If the device successfully processes a SET MAX ADDRESS command with an LBA less than the native max without error, and the 48-bit Address feature set is supported, then the value placed in IDENTIFY DEVICE data words 100..103 (see 7.18.7.53) shall be the same as the value placed in IDENTIFY DEVICE data words 60..61.

A host should not issue more than one non-volatile SET MAX ADDRESS command or SET MAX ADDRESS EXT command after a power-on or hardware reset.

A device shall not change the content in IDENTIFY DEVICE data words 60..61 or IDENTIFY DEVICE data words 100..103 during processing of a software reset.

The contents of IDENTIFY DEVICE data and the maximum LBA shall not be changed if a SET MAX ADDRESS command fails.

After a successful SET MAX ADDRESS command using a new maximum LBA the content of all IDENTIFY DEVICE data words shall comply with 4.12.4 and the content of IDENTIFY DEVICE data words 60..61 shall be equal to the new Maximum LBA + 1.

A successful READ NATIVE MAX ADDRESS command should immediately precede a SET MAX ADDRESS command . If the SET MAX ADDRESS command is not preceded by a successful READ NATIVE MAX ADDRESS command, the device shall return command aborted for the SET MAX ADDRESS command or process one of the following commands:

    a) SET MAX SET PASSWORD;
    b) SET MAX LOCK;
    c) SET MAX UNLOCK; or
    d) SET MAX FREEZE LOCK.

The result depends on the value of the Feature field (see table 137).

When the device successfully processes a SET MAX ADDRESS command with the value returned by the READ NATIVE MAX ADDRESS command, the device shall:

    e) If the value returned by the READ NATIVE MAX EXT command is greater than the value returned by the READ NATIVE MAX command, then IDENTIFY DEVICE data words 100..103 shall indicate the value returned by the READ NATIVE MAX EXT command and IDENTIFY DEVICE data words 60..61 shall comply with 4.12.4; or
    f) Otherwise IDENTIFY DEVICE data words 60..61 shall indicate the value returned by the READ NATIVE MAX command and IDENTIFY DEVICE data words 100..103 shall comply with 4.12.4.

7.51.2.3 Inputs

7.51.2.3.1 Overview

See table 137 for the SET MAX ADDRESS command inputs.

Table 137 — SET MAX ADDRESS command inputs

Name	Description
Feature	N/A
Count	**Bit Description** 7:1 N/A 0 Volatile_Value (V_V) - See 7.51.2.3.2.
LBA	Maximum LBA
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 F9h

7.51.2.3.2 Volatile_Value (V_V)

If the V_V bit is set to one, then during processing of a power-on reset or a hardware reset, a device shall not change the content in IDENTIFY DEVICE data words 60..61 (see 7.18.7.22) or IDENTIFY DEVICE data 100..103 (see 7.18.7.53).

If the V_V bit is cleared to zero, then during processing of a power-on reset or a hardware reset, a device shall change the content in IDENTIFY DEVICE data words 60..61 (see 7.18.7.22) and IDENTIFY DEVICE data words 100..103 (see 7.18.7.53) to be a value one greater than the value of either:

    a) the value in the LBA field in the most recent SET MAX ADDRESS command or SET MAX ADDRESS EXT command that completed without error in which the V_V bit was set to one; or

    b) if no SET MAX ADDRESS command or SET MAX ADDRESS EXT command has completed without error, then the native max address.

7.51.2.4 Normal Outputs

See Table 224.

7.51.2.5 Error Outputs

If:

    a) the value in the LBA field exceeds the capacity of the device;
    b) a host protected area has been established by a SET MAX ADDRESS EXT command;
    c) the device is HPA Locked (see 4.12.6); or
    d) the device has successfully processed a SET MAX FREEZE LOCK command,

then the device shall return command aborted.

If the Maximum LBA is less than the native max address, then the ID Not Found bit (see 6.3.6) shall be set to one if a previous non-volatile SET MAX ADDRESS command has been processed since the last power-on or hardware reset . The Abort bit shall be set to one if the maximum value requested exceeds the device capacity, a host protected area has been established by a SET MAX ADDRESS EXT command, the device is HPA Locked

(see 4.12.6) or has successfully processed a SET MAX FREEZE LOCK command, or the command is not immediately preceded by a READ NATIVE MAX ADDRESS command . See table 251.

7.51.3 SET MAX FREEZE LOCK – F9h/04h, Non-Data

7.51.3.1 Feature Set

This 28-bit command is for devices that implement the HPA security extensions (see 4.12.2).

7.51.3.2 Description

The SET MAX FREEZE LOCK command shall cause any subsequent SET MAX commands to return command aborted until a power-on reset has been processed by the device.

The following commands are disabled by the SET MAX FREEZE LOCK command:

  a) SET MAX ADDRESS;
  b) SET MAX SET PASSWORD;
  c) SET MAX LOCK;
  d) SET MAX UNLOCK; and
  e) SET MAX ADDRESS EXT.

This command should not be immediately preceded by a READ NATIVE MAX ADDRESS command . If this command is immediately preceded by a READ NATIVE MAX ADDRESS command, it shall be interpreted as a SET MAX ADDRESS command.

7.51.3.3 Inputs

See table 138 for the SET MAX FREEZE LOCK command inputs.

Table 138 — SET MAX FREEZE LOCK command inputs

Name	Description
Feature	04h
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 F9h

7.51.3.4 Normal Outputs

See table 215.

7.51.3.5 Error Outputs

See table 242.

7.51.4 SET MAX LOCK - F9h/02h, Non-Data

7.51.4.1 Feature Set

This 28-bit command is for devices that implement the HPA security extensions (see 4.12.2).

7.51.4.2 Description

if the device successfully processes a SET MAX LOCK command, then:

   a)   the device is HPA Locked;
   b)   the HPA Security Extensions unlock counter (see x.x) shall be set to a value of five; and
   c)   any other SET MAX commands except SET MAX UNLOCK command and SET MAX FREEZE LOCK
        command shall return command aborted.

The device shall remain in this state until a power-on reset has been processed or command completion without error of a SET MAX UNLOCK command or SET MAX FREEZE LOCK command.

This command should not be immediately preceded by a READ NATIVE MAX ADDRESS command . If this command is immediately preceded by a READ NATIVE MAX ADDRESS command, it shall be interpreted as a SET MAX ADDRESS command.

7.51.4.3 Inputs

See table 139 for the SET MAX FREEZE LOCK command inputs.

Table 139 — SET MAX FREEZE LOCK command inputs

Name	Description
Feature	02h
Count	N/A
LBA	N/A

Device	**Bit Description**
	
	  7 Obsolete
	
	  6 N/A
	
	  5 Obsolete
	
	  4 Transport Dependent - See 6.2.12
	
	3:0 Reserved

Command	7:0 F9h

7.51.4.4 Normal Outputs

See table 215.

7.51.4.5 Error Outputs

The Abort bit shall be set to one if the device is HPA Locked (see 4.12.6)

 or has successfully processed a SET MAX FREEZE LOCK command . See table 242.

7.51.5 SET MAX SET PASSWORD - F9h/01h, PIO Data-Out

7.51.5.1 Feature Set

This 28-bit command is for devices that implement the HPA security extensions (see 4.12.2).

7.51.5.2 Description

The SET MAX SET PASSWORD command requests a transfer of a single 512-byte block of data from the host . Table 141 defines the content of this 512-byte block of data . The password is not retained by the device after the device has processed a power-on reset.

> NOTE 23 — This password is not related to the passwords that are part of the Security feature set (see 4.22).

This command should not be immediately preceded by a READ NATIVE MAX ADDRESS command . If this command is immediately preceded by a READ NATIVE MAX ADDRESS command, it shall be interpreted as a SET MAX ADDRESS command.

7.51.5.3 Inputs

See table 140 for the SET MAX SET PASSWORD command inputs.

Table 140 — SET MAX SET PASSWORD command inputs

Name	Description
Feature	01h
Count	N/A
LBA	N/A

Device	**Bit Description**
	  7 Obsolete
	  6 N/A
	  5 Obsolete
	  4 Transport Dependent - See 6.2.12
	  3:0 Reserved

Command	7:0 F9h

7.51.5.4 Normal Outputs

See table 215.

7.51.5.5 Error Outputs

If a device is HPA Locked (see 4.12.6) or has successfully processed a SET MAX FREEZE LOCK command, then the device shall return command aborted . A device may return command completion with the Error bit set to one if an Interface CRC error has occurred . See table 251.

7.51.5.6 Output From the Host to the Device Data Structure

Table 141 — SET MAX SET PASSWORD data content

Word	Description
0	Reserved
1..16	Password (32 bytes)
17..255	Reserved

7.51.6 SET MAX SET PASSWORD DMA - F9h/05h, DMA

7.51.6.1 Feature Set

This 28-bit command is for devices that implement the HPA security extensions (see 4.12.2).

7.51.6.2 Description

See 7.51.5.2.

7.51.6.3 Inputs

See table 142 for the SET MAX SET PASSWORD DMA command inputs.

Table 142 — SET MAX SET PASSWORD DMA command inputs

Name	Description
Feature	05h
Count	N/A
LBA	N/A

Device	**Bit Description**
	
	  7 Obsolete
	
	  6 N/A
	
	  5 Obsolete
	
	  4 Transport Dependent - See 6.2.12
	
	3:0 Reserved

Command	7:0 F9h

7.51.6.4 Normal Outputs

See 7.51.5.4.

7.51.6.5 Error Outputs

See 7.51.5.5.

7.51.6.6 Output From the Host to the Device Data Structure

See 7.51.5.6.

7.51.7 SET MAX UNLOCK - F9h/03h, PIO Data-Out

7.51.7.1 Feature Set

This 28-bit command is mandatory for devices that implement the HPA security extensions (see 4.12.2).

7.51.7.2 Description

The SET MAX UNLOCK command requests a transfer of a single 512-byte block of data from the host . Table 141 defines the content of this data .

The password supplied in the data transferred shall be compared with the password set by the SET MAX SET PASSWORD command.

If the device is locked from HPA commands and the password compare fails, then the device shall return command aborted and decrement the HPA Security Extensions unlock counter (see 4.12.6) . This counter shall be decremented for each password mismatch when the SET MAX UNLOCK command is issued and the device is locked from HPA commands . When this counter reaches zero in a device, then the device shall return command aborted for all subsequent SET MAX UNLOCK commands until after the device has processed a power-on reset.

> NOTE 24 — The HPA Security Extensions unlock counter is not related to the Security feature set unlock counter.

If the device is HPA Locked, the HPA Security Extensions unlock counter is not zero, and the password compare matches, then the device is HPA Unlocked (see 4.12.6) and all SET MAX commands shall be accepted.

This command should not be immediately preceded by a READ NATIVE MAX ADDRESS command . If this command is immediately preceded by a READ NATIVE MAX ADDRESS command, it shall be interpreted as a SET MAX ADDRESS command.

7.51.7.3 Inputs

See table 143 for the SET MAX UNLOCK command inputs.

Table 143 — SET MAX UNLOCK command inputs

Name	Description
Feature	03h
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 F9h

7.51.7.4 Normal Outputs

See table 215.

7.51.7.5 Error Outputs

If a device is not HPA Locked (see 4.12.6), then the device shall return command aborted . A device may return command completion with the Error bit set to one if an Interface CRC error has occurred . See table 243.

7.51.7.6 Output From the Host to the Device Data Structure

See 7.51.5.6.

7.51.8 SET MAX UNLOCK DMA - F9h/06h, DMA

7.51.8.1 Feature Set

This 28-bit command is optional for devices that implement the HPA security extensions (see 4.12.2).

7.51.8.2 Description

See 7.51.7.2.

7.51.8.3 Inputs

See table 144 for the SET MAX UNLOCK DMA command inputs.

Table 144 — SET MAX UNLOCK DMA command inputs

Name	Description
Feature	06h
Count	N/A
LBA	N/A
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 F9h

7.51.8.4 Normal Outputs

See 7.51.7.4.

7.51.8.5 Error Outputs

See 7.51.7.5.

7.51.8.6 Output From the Host to the Device Data Structure

See 7.51.7.6.

7.52 SET MAX ADDRESS EXT - 37h, Non-Data

7.52.1 Feature Set

This 48-bit command is for devices that implement both the HPA feature set (see 4.12) and the 48-bit Address feature set (see 4.4).

7.52.2 Description

The SET MAX ADDRESS EXT command shall cause all read and write access attempts to an LBA greater than the LBA specified by the successful SET MAX ADDRESS EXT command to be rejected with an ID Not Found error .

A host should not issue more than one non-volatile SET MAX ADDRESS EXT command after a power-on or hardware reset.

The contents of IDENTIFY DEVICE data (see table 54) and the maximum LBA shall not be changed if a SET MAX ADDRESS EXT command fails.

After a successful SET MAX ADDRESS EXT command using a new maximum LBA the content of all IDENTIFY DEVICE data words shall comply with 4.12.4.

A successful READ NATIVE MAX EXT command should immediately precede SET MAX ADDRESS EXT command . If the device receives a SET MAX ADDRESS EXT command that is not immediately preceded by READ NATIVE MAX EXT command, the device shall report command aborted.

7.52.3 Inputs

7.52.3.1 Overview

See table 145 for the SET MAX ADDRESS EXT command inputs.

Table 145 — SET MAX ADDRESS EXT command inputs

Name	Description
Feature	N/A
Count	**Bit Description** 15:1 N/A 0 Volatile_Value (V_V) - See 7.52.3.2.
LBA	Maximum LBA
Device	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 37h

7.52.3.2 Volatile_Value (V_V)

If the V_V bit is set to one, then during processing of a power-on reset or a hardware reset, a device shall not change the content in IDENTIFY DEVICE data words 60..61 (see 7.18.7.22) or IDENTIFY DEVICE data 100..103 (see 7.18.7.53).

If the V_V bit is cleared to zero, then during processing of a power-on or hardware reset, a device shall:

    a) change the content in IDENTIFY DEVICE data words 100..103 to be a value one greater than the value of either:

        A) the value in the LBA field in the most recent SET MAX ADDRESS command or SET MAX ADDRESS EXT command that completed without error in which the V_V bit was set to one; or

        B) if no SET MAX ADDRESS command or SET MAX ADDRESS EXT command has completed without error, then the native max address;
            and

    b) change the content in IDENTIFY DEVICE data words 60..61 to be the value in IDENTIFY DEVICE data words 100..103 or 0FFF_FFFFh, whichever is less.

Regardless of the setting of the V_V bit, a device shall not change the content in IDENTIFY DEVICE data words 60..61 or IDENTIFY DEVICE data 100..103 during processing of a software reset.

7.52.4 Normal Outputs

See table 228.

7.52.5 Error Outputs

If:

    a) the value in the LBA field exceeds the capacity of the device;

    b) a host protected area has been established by a SET MAX ADDRESS command;

    c) this command is not immediately preceded by a READ NATIVE MAX ADDRESS EXT command

    d) the device is HPA Locked (see 4.12.6); or

    e) the device has successfully processed a SET MAX FREEZE LOCK command,

then the device shall return command aborted.

If the Maximum LBA (see 4.12.4) is less than the native max address, then the ID Not Found bit (see 6.3.6) shall be set to one if a previous non-volatile SET MAX ADDRESS EXT command has been processed since the last power-on or hardware reset . See table 263.

7.53 SET MULTIPLE MODE - C6h, Non-Data

7.53.1 Feature Set

This 28-bit command is for ATA devices (see 4.2).

7.53.2 Description

The SET MULTIPLE MODE command establishes the number of logical sectors in the DRQ data block count for the READ MULTIPLE command, READ MULTIPLE EXT command, WRITE MULTIPLE command, and WRITE MULTIPLE EXT command . The content of the Count field shall be less than or equal to the value in IDENTIFY DEVICE data word 47 bits (7:0) (see 7.18.7.15) . The host should set the content of the Count field to 1, 2, 4, 8, 16, 32, 64, or 128.

Devices shall support the DRQ data block size specified in the IDENTIFY DEVICE data word 47 bits (7:0) (see 7.18.7.15), and may also support smaller values.

Upon receipt of the command, the device checks the Count field . If the content of the Count field is not zero, the Count field contains a valid value, and the DRQ data block count is supported, then the value in the Count field is used for all subsequent READ MULTIPLE commands, READ MULTIPLE EXT commands, WRITE MULTIPLE commands, WRITE MULTIPLE EXT commands, and WRITE MULTIPLE FUA EXT commands and their processing is enabled.

If the content of the Count field is zero and the SET MULTIPLE command completes without error, then the device shall respond to any subsequent READ MULTIPLE command, READ MULTIPLE EXT command, WRITE MULTIPLE command, WRITE MULTIPLE EXT command, and WRITE MULTIPLE FUA EXT command with command aborted until a subsequent successful SET MULTIPLE command completion where the Count field is not set to zero.

If the content of the Count field is zero, then the device may:

   a) disable multiple mode (i.e., respond with command aborted for all subsequent READ MULTIPLE commands, READ MULTIPLE EXT commands, WRITE MULTIPLE commands, WRITE MULTIPLE EXT commands, and WRITE MULTIPLE FUA EXT commands);
   b) return command aborted for all SET MULTIPLE MODE commands; or
   c) retain the previous multiple mode settings.

After a successful SET MULTIPLE command the device shall report the valid value set by that command in IDENTIFY DEVICE data word 59 (see 7.18.7.21) .

After a power-on or hardware reset, if IDENTIFY DEVICE data word 59 bit 8 is set to one and IDENTIFY DEVICE data word 59 bits (7:0) are cleared to zero, a SET MULTIPLE command is required before issuing a READ MULTIPLE command, READ MULTIPLE EXT command, WRITE MULTIPLE command, or WRITE MULTIPLE EXT command . If bit 8 is set to one and bits (7:0) are not cleared to zero, a SET MULTIPLE command may be issued to change the multiple value required before issuing a READ MULTIPLE command, READ MULTIPLE EXT command, WRITE MULTIPLE command, or WRITE MULTIPLE EXT command.

7.53.3 Inputs

See table 146 for the SET MULTIPLE MODE command inputs.

Table 146 — SET MULTIPLE MODE command inputs

Name	Description
Feature	N/A
Count	DRQ data block count
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 C6h

7.53.4 Normal Outputs

See table 215.

7.53.5 Error Outputs

The Abort bit shall be set to one if the block count is not supported . See table 239 .

7.54 SLEEP - E6h, Non-Data

7.54.1 Feature Set

This 28-bit command is for devices implementing the Power Management feature set (see 4.19).

7.54.2 Description

The SLEEP command causes the device to enter Sleep mode . The device shall exit Sleep (i.e., PM3 state (see 4.19.4)) only after processing a hardware reset, a software reset, or a DEVICE RESET command.

A device shall not power-on in Sleep mode.

7.54.3 Inputs

See table 147 for the SLEEP command inputs.

Table 147 — SLEEP command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 E6h

7.54.4 Normal Outputs

See table 215.

7.54.5 Error Outputs

See table 239.

7.55 SMART

7.55.1 Overview

Individual SMART commands are identified by the value placed in the Feature field . Table 148 shows these values.

Table 148 — SMART Feature field values

Value	Command
00h-CFh	Reserved
D0h	SMART READ DATA (see 7.55.6)
D1h	Obsolete
D2h	SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE (see 7.55.3)
D3h	Obsolete
D4h	SMART EXECUTE OFF-LINE IMMEDIATE (see 7.55.5)
D5h	SMART READ LOG (see 7.55.7)
D6h	SMART WRITE LOG (see 7.55.9)
D7h	Obsolete
D8h	SMART ENABLE OPERATIONS (see 7.55.4)
D9h	SMART DISABLE OPERATIONS (see 7.55.2)
DAh	SMART RETURN STATUS (see 7.55.8)
DBh	Obsolete
DCh-DFh	Reserved
E0h-FFh	vendor specific

7.55.2 SMART DISABLE OPERATIONS - B0h/D9h, Non-Data

7.55.2.1 Feature Set

This 28-bit command is for devices that implement the SMART feature set (see 4.23).

7.55.2.2 Description

The SMART DISABLE OPERATIONS command shall disable all SMART operations . After completion of this command without error the device shall report command aborted for all other SMART commands (e.g., SMART DISABLE OPERATIONS commands), except for the SMART ENABLE OPERATIONS command and the SCT Command Transport commands, which shall be processed as defined . The state of SMART (i.e., enabled or disabled) shall be preserved by the device during all power-on reset events.

7.55.2.3 Inputs

See table 149 for the SMART DISABLE OPERATIONS command inputs.

Table 149 — SMART DISABLE OPERATIONS command inputs

Name	Description
Feature	D9h
Count	N/A
LBA	**Bit** **Description** 27:24 N/A 23:8 C24Fh 7:0 N/A
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B0h

7.55.2.4 Normal Outputs

See table 215.

7.55.2.5 Error Outputs

The Abort bit shall be set to one if SMART is not enabled, or if an input value is invalid . See table 239.

7.55.3 SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE - B0h/D2h, Non-Data

7.55.3.1 Feature Set

This 28-bit command is for devices that implement the SMART feature set (see 4.23).

7.55.3.2 Description

The SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE command enables and disables the optional attribute autosave feature of the device . This command may either allow the device, after some vendor specified event, to save the device updated attributes to non-volatile memory; or this command may cause the autosave feature to be disabled . The state of the attribute autosave feature, either enabled or disabled, shall be preserved by the device during all power and reset events.

The Count field set to zero shall cause the device to disable the attribute autosave feature . Disabling this feature does not preclude the device from saving SMART data to non-volatile memory during some other normal operation (e.g., during a power-on or power-off sequence or during an error recovery sequence).

The Count field set to F1h shall cause the device to enable the attribute autosave feature . If the Count field is not set to 00h or F1h, then the actions taken by a device are vendor specific.

If the device receives a command while processing the autosave routine the device shall begin processing the command within two seconds.

7.55.3.3 Inputs

See table 150 for the SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE command inputs.

Table 150 — SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE command inputs

Name	Description
Feature	D2h
Count	**Value** **Description** 00h Disable attribute autosave 01h-F0h Vendor specific F1h Enable attribute autosave F2h-FFh Vendor specific
LBA	**Bit** **Description** 27:24 N/A 23:8 C24Fh 7:0 N/A
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B0h

7.55.3.4 Normal Outputs

See table 215.

7.55.3.5 Error Outputs

The Abort bit shall be set to one if SMART is not enabled, or if an input value is invalid . See table 239 .

7.55.4 SMART ENABLE OPERATIONS - B0h/D8h, Non-Data

7.55.4.1 Feature Set

This 28-bit command is for devices that implement the SMART feature set (see 4.23).

7.55.4.2 Description

The SMART ENABLE OPERATIONS command enables access to all available SMART capabilities within the device . The state of SMART, either enabled or disabled, shall be preserved by the device during all power and reset events . Once enabled, the receipt of subsequent SMART ENABLE OPERATIONS commands shall not affect any SMART data or functions.

7.55.4.3 Inputs

See table 151 for the SMART ENABLE OPERATIONS command inputs.

Table 151 — SMART ENABLE OPERATIONS command inputs

Name	Description
Feature	D8h
Count	N/A
LBA	**Bit Description** 27:24 N/A 23:8 C24Fh 7:0 N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B0h

7.55.4.4 Normal Outputs

See table 215.

7.55.4.5 Error Outputs

See table 239.

7.55.5 SMART EXECUTE OFF-LINE IMMEDIATE - B0h/D4h, Non-Data

7.55.5.1 Feature Set

This 28-bit command is for devices that implement the SMART feature set (see 4.23).

7.55.5.2 Description

7.55.5.2.1 Overview

The SMART EXECUTE OFF-LINE IMMEDIATE command causes the device to initiate the optional set of activities that collect SMART data in an off-line mode and then preserve this data across power and reset events, or process a vendor specific self-diagnostic test routine in either captive or off-line mode . Table 152 lists the SMART EXECUTE OFF-LINE IMMEDIATE Subcommands.

Table 152 — SMART EXECUTE OFF-LINE IMMEDIATE Subcommands

Value	Description of subcommand to be processed
00h	Execute SMART off-line routine (see 7.55.5.2.4) in off-line mode [a]
01h	Execute SMART Short self-test routine (see 7.55.5.2.5) in off-line mode [a]
02h	Execute SMART Extended self-test routine (see 7.55.5.2.6) in off-line mode [a]
03h	Execute SMART Conveyance self-test routine (see 7.55.5.2.7) in off-line mode [a]
04h	Execute SMART Selective self-test routine (see 7.55.5.2.8) in off-line mode [a]
05h-3Fh	Reserved
40h-7Eh	Vendor specific
7Fh	Abort off-line mode self-test routine
80h	Reserved
81h	Execute SMART Short self-test routine (see 7.55.5.2.5) in captive mode [b]
82h	Execute SMART Extended self-test routine (see 7.55.5.2.6) in captive mode [b]
83h	Execute SMART Conveyance self-test routine (see 7.55.5.2.7) in captive mode [b]
84h	Execute SMART Selective self-test routine (see 7.55.5.2.8) in captive mode [b]
85h-8Fh	Reserved
90h-FFh	Vendor specific
[a] See 7.55.5.2.2 [b] See 7.55.5.2.3	

7.55.5.2.2 Off-line mode

The following describes the protocol for processing a SMART EXECUTE OFF-LINE IMMEDIATE subcommand routine, including a self-test routine, in the off-line mode:

1) the device shall report command completion before processing the subcommand routine;
2) the device shall remain ready to receive a new command during processing of the subcommand routine;
3) if the device is in the process of performing the subcommand routine and is interrupted by any new command from the host except a SLEEP command, SMART DISABLE OPERATIONS command, SMART EXECUTE OFF-LINE IMMEDIATE, command or STANDBY IMMEDIATE command, then the device shall suspend or abort the subcommand routine and begin processing the new command within two seconds after receipt of the new command . After servicing the interrupting command, the device may re-initiate or resume the subcommand routine without any additional commands from the host (see 7.55.6.10);
4) if the device is in the process of performing a subcommand routine and is interrupted by a SLEEP command from the host, then the device may abort the subcommand routine and process the SLEEP command . If the device is in the process of performing any self-test routine and is interrupted by a SLEEP command, then the device shall abort the subcommand routine and process the SLEEP command;

5)   if the device is in the process of performing the subcommand routine and is interrupted by a SMART DISABLE OPERATIONS command, then the device shall suspend or abort the subcommand routine and begin processing the new command within two seconds after receipt of the command . Upon receipt of the next SMART ENABLE OPERATIONS command the device may, either re-initiate the subcommand routine or resume the subcommand routine from where it had been previously suspended;

6)   if the device is in the process of performing the subcommand routine and is interrupted by a SMART EXECUTE OFF-LINE IMMEDIATE command, then the device shall abort the subcommand routine and begin processing the new command within two seconds after receipt of the command . The device shall then process the new SMART EXECUTE OFF-LINE IMMEDIATE subcommand;

7)   if the device is in the process of performing the subcommand routine and is interrupted by a STANDBY IMMEDIATE command or IDLE IMMEDIATE command, then the device shall suspend or abort the subcommand routine, and begin processing the new command within two seconds after receipt of the command . After receiving a new command that causes the device to exit a power saving mode, the device shall initiate or resume the subcommand routine without any additional commands unless these activities were aborted by the host;

8)   while the device is performing the subcommand routine it shall not change power states (e.g., as a result of its Standby timer (see 4.19.3) expiring); and

9)   if a test failure occurs while a device is performing a self-test routine, then the device may discontinue the testing and place the test results in the Self-test execution status byte (see table 155).

7.55.5.2.3 Captive mode

When processing a self-test in captive mode, the device processes the self-test routine after receipt of the command . At the end of the self-test routine the device places the results of this self-test routine in the Self-test execution status byte (see table 155) and reports command completion . If an error occurs while a device is performing the self-test routine, then the device may discontinue its testing, place the results of this self-test routine in the Self-test execution status byte, and complete the command.

7.55.5.2.4 SMART off-line routine

the SMART off-line routine shall only be processed in the off-line mode (see 7.55.5.2.2) . The results of this routine are placed in the Off-line data collection status byte (see table 156).

7.55.5.2.5 SMART Short self-test routine

Depending on the value in the LBA field (7:0) (see table 152), the SMART Short self-test routine may be processed in either the captive mode or the off-line mode . The SMART Short self-test routine should take on the order of minutes to complete (see table 155).

7.55.5.2.6 SMART Extended self-test routine

Depending on the value in the LBA field (7:0) (see table 152), the SMART Extended self-test routine may be processed in either the captive mode or the off-line mode . The SMART Extended self-test routine should take on the order of tens of minutes to complete (see table 155).

7.55.5.2.7 SMART Conveyance self-test routine

Depending on the value in the LBA field (7:0) (see table 152), the SMART Conveyance self-test routine may be processed in either the captive mode or the off-line mode . The SMART Conveyance self-test routine may identify damage incurred during transporting of the device . The SMART Conveyance self-test routine should take on the order of minutes to complete (see table 155).

7.55.5.2.8 SMART Selective self-test routine

If the SMART Selective self-test routine is implemented, then all features of this self-routine shall be implemented . Support for the SMART Selective self-test routine is indicated in off-line data collection capabilities (see 7.55.6.10) . When the value in the LBA field (7:0) is 4 or 132, the SMART Selective self-test routine shall be processed . This self-test routine shall include the initial tests performed by the Extended self-test routine plus a selectable read scan . The host should not write the Selective self-test log while the processing of a SMART Selective self-test routine is in progress.

A read scan of the specified areas of the media is requested by setting the test spans to be read scanned in the Selective self-test log (see A.15) . The device shall process the specified test spans and they shall be read

scanned in their entirety . If bit 1 in the Feature flags field of the Selective self-test log (see A.15) is cleared to zero, then the device shall not perform an off-line scan following the Selective self-test.

The Selective self-test log is updated as the self-test proceeds indicating test progress . When all specified test spans have been completed, the test is terminated and the appropriate self-test execution status is reported in the SMART READ DATA response depending on the occurrence of errors . Figure 17 shows an example of a Selective self-test definition with three test spans defined . In this example, the test terminates when all three test spans have been scanned.
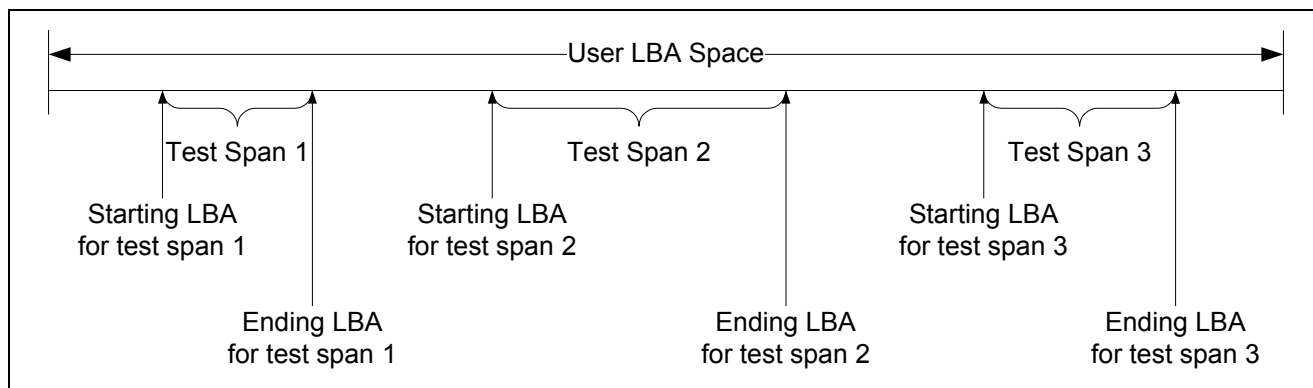
Figure 17 — Selective self-test span example

If bit 1 of the Feature flags field in the Selective self-test log (see A.15) is set to one, then after the scan of the selected spans described in this subclause, the device shall scan the rest of media in an off-line mode . If an error occurs during the scanning of the test spans, the error is reported in the self-test execution status in the SMART READ DATA response and the off-line scan is not processed . When the test spans defined have been scanned, then the device shall:

   a)   set the off-line scan pending and active flags in the Selective self-test log to one;
   b)   set the span under test to a value greater than five;
   c)   set the self-test execution status in the SMART READ DATA response to 00h;
   d)   set a value of 03h in the off-line data collection status in the SMART READ DATA response; and
   e)   proceed to process an off-line read scan through all areas not included in the test spans.

This off-line read scan shall be completed with no pauses between block reads . Any errors encountered shall not be reported to the host . Instead Error locations may be logged for future reallocation . If the device is powered-down before the off-line scan is completed, the off-line scan shall resume when the device is powered up . From power-up, the resumption of the scan shall be delayed the time indicated in the Selective self-test pending time field in the Selective self-test log (see A.15) . During this delay time the pending flag shall be set to one and the active flag shall be set to zero in the Selective self-test log . Once the time expires, the active flag shall be set to one, and the off-line scan shall resume . When the entire media has been scanned, the off-line scan shall terminate, both the pending and active flags shall be cleared to zero, and the off-line data collection status in the SMART READ DATA response shall be set to 02h indicating completion.

The time to complete off-line testing and the self-test polling times do not apply to the selective self-test . Progress through the test spans is indicated in the selective self-test log.

When bit 3 in the Selective self-test feature flags field is set to one (see A.15), a device shall continue processing the Selective self-test after processing a hardware reset or a software reset . When bit 3 in the Selective self-test feature flags field is cleared to zero, a device shall abort the Selective self-test during processing a hardware reset or a software reset.

If a device receives a SMART EXECUTE OFF-LINE IMMEDIATE command with the Abort off-line test routine subcommand, then the device shall abort the Selective self-test.

If a device receives a SMART EXECUTE OFF-LINE IMMEDIATE command specifying that the device perform a self-test while a selective self-test is in progress, the device shall abort the selective self-test and process the specified self-test.

7.55.5.3 Inputs

See table 153 for the SMART EXECUTE OFF-LINE IMMEDIATE command inputs.

Table 153 — SMART EXECUTE OFF-LINE IMMEDIATE command inputs

Name	Description
Feature	D4h
Count	N/A
LBA	**Bit Description** 27:24 N/A 23:8 C24Fh 7:0 Table 152 defines the subcommand that shall be processed
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B0h

7.55.5.4 Normal Outputs

See table 225.

7.55.5.5 Error Outputs

The ID Not Found bit shall be set to one if the SMART data is not available . The Abort bit shall be set to one if SMART is not enabled or if a self-test fails while executing a sequence in captive mode . See table 254.

7.55.6 SMART READ DATA - B0h/D0h, PIO Data-In

7.55.6.1 Feature Set

This 28-bit command is for devices that implement the SMART feature set (see 4.23).

7.55.6.2 Description

The SMART READ DATA command returns the Device SMART data structure to the host.

7.55.6.3 Inputs

See table 154 for the SMART READ DATA command inputs.

Table 154 — SMART READ DATA command inputs

Name	Description
Feature	D0h
Count	N/A
LBA	**Bit Description** 27:24 N/A 23:8 C24Fh 7:0 N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B0h

7.55.6.4 Normal Outputs

See table 215.

7.55.6.5 Error Outputs

If SMART data is uncorrectable, then the device shall return command completion with the Uncorrectable bit set to one . If the SMART data is not available or the data structure checksum is invalid, then the device shall return command completion with the ID Not Found bit set to one . If SMART is not enabled or if field values are invalid, then the device shall return command aborted . A device may return command completion with the Error bit set to one if an Interface CRC error has occurred . See table 260.

> NOTE 25 — There is no defined mechanism for a device to return an Interface CRC error status that may have occurred during the last data block of a PIO-in data transfer . There may be other mecha-nisms in which a host may verify that an Interface CRC error occurred in these cases.

7.55.6.6 Input From the Device to the Host Data Structure

Table 155 defines the 512 bytes that make up the Device SMART data structure.

Table 155 — Device SMART data structure

Offset	F/V	Description
0..361	X	Vendor specific
362	V	Off-line data collection status
363	X	Self-test execution status byte
364..365	V	Total time in seconds to complete off-line data collection activity (word)
366	X	Vendor specific
367	F	Off-line data collection capability
368..369	F	SMART capability
370	F	Error logging capability 7:1 Reserved 0 1=Device error logging supported
371	X	Vendor specific
372	F	Short self-test routine recommended polling time (in minutes)
373	F	Extended self-test routine recommended polling time in minutes . If FFh, use bytes 375 and 376 for the polling time.
374	F	Conveyance self-test routine recommended polling time in minutes
375..376	F	Extended self-test routine recommended polling time in minutes (word)
377..385	R	Reserved
386..510	X	Vendor specific
511	V	Data structure checksum
Key: F = the content of the byte is fixed and does not change. V = the content of the byte is variable and may change depending on the state of the device or the commands processed by the device. X = the content of the byte is vendor specific and may be fixed or variable. R = the content of the byte is reserved and shall be zero.		

7.55.6.7 Off-line collection status byte

The value of the off-line data collection status byte defines the current status of the off-line activities of the device . Table 156 lists the values and their respective definitions.

Table 156 — Off-line data collection status byte values

Value	Description
00h or 80h	Off-line data collection activity was never started.
01h	Reserved
02h or 82h	Off-line data collection activity was completed without error.
03h	Off-line activity in progress.
04h or 84h	Off-line data collection activity was suspended by an interrupting command from host.
05h or 85h	Off-line data collection activity was aborted by an interrupting command from host.
06h or 86h	Off-line data collection activity was aborted by the device with a fatal error.
07h-3Fh	Reserved
40h-7Fh	Vendor specific
81h	Reserved
83h	Reserved
87h-BFh	Reserved
C0h-FFh	Vendor specific

7.55.6.8 Self-test execution status byte

The self-test execution status byte reports the status of the self-test routine as follows:

a) for bits (3:0) (i.e., Percent Self-Test Remaining), the value indicates an approximation of the percent of the self-test routine remaining until completion in ten percent increments . Valid values are nine through zero . A value of zero indicates that the self-test routine is complete . A value of nine indicates 90% of total test time is remaining; and

b) for bits (7:4) (i.e., Self-test Execution Status), the value:
   A) indicates the current Self-test Execution Status (see table 157);
   B) may be cleared to zero when the device processes a power-on reset; and
   C) shall be retained when the device processes a software reset or hardware reset.

Table 157 — Self-test execution status values

Value	Description
0h	Indicates a previous self-test routine completed without error or no self-test status is available
1h	The self-test routine was aborted by the host
2h	The self-test routine was interrupted by the host with a hardware or software reset
3h	A fatal error or unknown test error occurred while the device was executing its self-test routine and the device was unable to complete the self-test routine.
4h	The previous self-test completed having a test element that failed and the test element that failed is not known.
5h	The previous self-test completed having the electrical element of the test failed.
6h	The previous self-test completed having the servo and/or seek test element of the test failed.
7h	The previous self-test completed having the read element of the test failed.
8h	The previous self-test completed having a test element that failed and the device is suspected of having handling damage.
9h-Eh	Reserved.
Fh	Self-test routine in progress.

7.55.6.9 Total time to complete off-line data collection

The total estimated time in seconds to complete off-line data collection activity word specifies how many seconds the device requires to complete the sequence of off-line data collection activity . Valid values for this word are from 0001h to FFFFh.

7.55.6.10 Off-line data collection capabilities

Table 158 defines the off-line data collection capability bits . If the value of all of these bits is cleared to zero, then no off-line data collection is implemented by this device.

Table 158 — Offline Data Collection Capabilities

Bit	Description
7	Reserved
6	Selective self-test implemented - If this bit is cleared to zero, the device does not implement the Selective self-test routine . If this bit is set to one, the device implements the Selective self-test routine.
5	Conveyance self-test implemented - If this bit is cleared to zero, the device does not implement the Conveyance self-test routines . If this bit is set to one, the device implements the Conveyance self-test routines.
4	Self-test implemented - If this bit is cleared to zero, the device does not implement the Short and Extended self-test routines . If this bit is set to one, the device implements the Short and Extended self-test routines.
3	Off-line read scanning implemented - If this bit is cleared to zero, the device does not support off-line read scanning . If this bit is set to one, the device supports off-line read scanning.
2	Abort/restart off-line by host - If this bit is set to one, then the device shall abort all off-line data collection activity initiated by a SMART EXECUTE OFF-LINE IMMEDIATE command upon receipt of a new command within 2 seconds of receiving the new command . If this bit is cleared to zero, the device shall suspend off-line data collection activity after an interrupting command and resume off-line data collection activity after some vendor-specified event.
1	Vendor specific.
0	EXECUTE OFF-LINE IMMEDIATE implemented - If this bit is set to one, then the SMART EXECUTE OFF-LINE IMMEDIATE command is implemented by this device . If this bit is cleared to zero, then the SMART EXECUTE OFF-LINE IMMEDIATE command is not implemented by this device.

7.55.6.11 SMART capabilities

The following defines the SMART capabilities bits:

a) If bit 0 is set to one, then the device saves SMART data prior to going into a power saving mode (i.e., Idle, Standby, or Sleep) or upon return to Active mode or Idle mode from a Standby mode (see 4.19.4) . If bit 0 is cleared to zero, then the device does not save SMART data prior to going into a power saving mode (Idle, Standby, or Sleep) or upon return to Active mode or Idle mode from a Standby mode;

b) Bit 1 shall be set to one to indicate that the device supports the SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE command; and

c) Bits (15:2) are reserved.

7.55.6.12 Self-test routine recommended polling time

The self-test routine recommended polling time shall be equal to the estimated number of minutes that is the minimum recommended time before which the host should begin polling for test completion status . Actual test time may be several times this value . The host should wait at least this long before sending the first SMART READ DATA command to check for test completion status . Polling before this time may extend the self-test processing time or abort the test depending on the state of Offline Data Collection Capabilities bit 2 (see table 158) . Subsequent checking by the host should be at a vendor specific interval.

7.55.6.13 Data structure checksum

The data structure checksum is the two's complement of the sum of the first 511 bytes in the data structure . Each byte shall be added with unsigned arithmetic, and overflow shall be ignored . The sum of all 512 bytes shall be zero when the checksum is correct . The checksum is placed in byte 511.

7.55.7 SMART READ LOG - B0h/D5h, PIO Data-In

7.55.7.1 Feature Set

This 28-bit command is for devices that implement the SMART feature set (see 4.23).

7.55.7.2 Description

The SMART READ LOG command returns the specified log to the host . See table A.2 for the list of logs.

7.55.7.3 Inputs

See table 159 for the SMART READ LOG command inputs.

Table 159 — SMART READ LOG command inputs

Name	Description
Feature	D5h
Count	Specifies the number of log pages to be read from the specified log . The log transferred by the ATA device shall start at the first page in the specified log, regardless of the Count requested
LBA	**Bit Description** 27:24 N/A 23:8 C24Fh 7:0 Log Address - Specifies the log to be read as described in table A.2 . See 7.30.3.3 for more information
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B0h

7.55.7.4 Normal Outputs

See table 215.

7.55.7.5 Error Outputs

The Uncorrectable Error bit shall be set to one if SMART data is uncorrectable . The ID Not Found bit shall be set to one if the data is not available or the data structure checksum is invalid . The Abort bit shall be set to one if SMART is not enabled, if the Count field is cleared to zero, or if field values are invalid . The Abort bit shall be set to one if the Count is larger than the log size reported in the SMART Log Directory (see A.3) . A device may return command completion with the Error bit set to one if an Interface CRC error has occurred . See table 260.

7.55.8 SMART RETURN STATUS - B0h/DAh, Non-Data

7.55.8.1 Feature Set

This 28-bit command is for devices that implement the SMART feature set (see 4.23).

7.55.8.2 Description

The SMART RETURN STATUS command causes the device to communicate the reliability status of the device to the host.

7.55.8.3 Inputs

See table 160 for the SMART RETURN STATUS command inputs.

Table 160 — SMART RETURN STATUS command inputs

Name	Description
Feature	DAh
Count	N/A
LBA	**Bit Description** 27:24 N/A 23:8 C24Fh 7:0 N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B0h

7.55.8.4 Normal Outputs

See table 226.

7.55.8.5 Error Outputs

The Abort bit shall be set to one if SMART is not enabled . See table 239.

7.55.9 SMART WRITE LOG - B0h/D6h, PIO Data-Out

7.55.9.1 Feature Set

This 28-bit command is for devices that implement the SMART feature set (see 4.23).

7.55.9.2 Description

The SMART WRITE LOG command specifies the log to be written as described in table A.2 . This command causes the device to write the specified number of log pages to the specified log . See table A.2 for the list of logs.

7.55.9.3 Inputs

7.55.9.3.1 Overview

See table 161 for the SMART WRITE LOG command inputs.

Table 161 — SMART WRITE LOG command inputs

Name	Description
Feature	D6h
Count	Specifies the number of log pages that shall be written . The data transferred to the device shall be stored starting at the first block in the specified log . If the device receives a value of zero in this field, then the device shall report command aborted
LBA	**Bit Description** 27:24 N/A 23:8 C24Fh 7:0 Log Address - See 7.55.9.3.2
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B0h

7.55.9.3.2 Log Address

A device may support a subset of the available logs . Support for individual logs is determined by support for the associated feature set . Support of the associated log(s) is mandatory for devices implementing the associated feature set . If the host attempts to write to a read only log address, the device shall return command aborted.

7.55.9.4 Normal Outputs

See table 215.

7.55.9.5 Error Outputs

If the SMART data is not available, then the device shall return command completion with the ID Not Found bit set to one . If SMART is not enabled, the log is not implemented, or the Count field is cleared to zero, then the device shall return command aborted for the command . A device may return command completion with the Error bit set to one if an Interface CRC error has occurred . See table 252.

7.56 STANDBY - E2h, Non-Data

7.56.1 Feature Set

This 28-bit command is for devices that implement the Power Management feature set (see 4.19).

7.56.2 Description

The STANDBY command causes the device to enter the Standby mode (see 4.19.4).

If the Count field is non-zero, then the Standby timer (see 4.19.3) shall be enabled . The value in the Count field shall be used to determine the time programmed into the Standby timer (see table 67).

If the Count field is zero, then the Standby timer is disabled.

7.56.3 Inputs

See table 162 for the STANDBY command inputs.

Table 162 — STANDBY command inputs

Name	Description
Feature	N/A
Count	This value shall determine the time period programmed into the Standby timer . Table 67 defines these values.
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 E2h

7.56.4 Normal Outputs

See table 215.

7.56.5 Error Outputs

See table 239.

7.57 STANDBY IMMEDIATE - E0h, Non-Data

7.57.1 Feature Set

This 28-bit command is for devices that implement the Power Management feature set (see 4.19).

7.57.2 Description

The STANDBY IMMEDIATE command causes the device to enter the Standby mode (see 4.19.4).

7.57.3 Inputs

See table 163 for the STANDBY IMMEDIATE command inputs.

Table 163 — STANDBY IMMEDIATE command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 E0h

7.57.4 Normal Outputs

See table 215.

7.57.5 Error Outputs

See table 239.

7.58 TRUSTED NON-DATA - 5Bh, Non-Data

7.58.1 Feature Set

This 28-bit command is for devices implementing the Trusted Computing feature set (see 4.27).

7.58.2 Description

The TRUSTED NON-DATA command delivers the SP Specific field (see 7.59.6) using the specified Security Protocol.

7.58.3 Inputs

7.58.3.1 Overview

See table 164 for the TRUSTED NON-DATA command inputs.

Table 164 — TRUSTED NON-DATA command inputs

Name	Description
Feature	Security Protocol (see 7.59.3.2)
Count	Reserved
LBA	**Bit Description** 27:25 Reserved 24 0 - Non-Data TRUSTED SEND, 1 - Non-Data TRUSTED RECEIVE 23:8 SP Specific (15:0) - Security Protocol Specific (see 7.59.6) 7:0 Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 5Bh

7.58.3.2 Security Protocol

If Bit 24 is cleared to zero, then see 7.61.3.2, otherwise, see 7.59.3.2.

7.58.4 Normal Outputs

If Bit 24 is cleared to zero, then see 7.61.4, otherwise, see 7.59.4.

7.58.5 Error Outputs

If Bit 24 is cleared to zero, then see 7.61.5, otherwise, see 7.59.5.

7.59 TRUSTED RECEIVE - 5Ch, PIO Data-In

7.59.1 Feature Set

This 28-bit command is for devices implementing the Trusted Computing feature set (see 4.27).

7.59.2 Description

The TRUSTED RECEIVE command retrieves security protocol information (see 7.59.6) or the results from one or more TRUSTED SEND commands.

Any association between a previous TRUSTED SEND command and the data transferred by a TRUSTED RECEIVE command depends on the protocol specified by the Security Protocol field (see table 166) . If the device has no data to transfer (e.g., the results for any previous TRUSTED SEND commands are not yet available), the device may transfer data indicating it has no other data to transfer .

Indications of data overrun or underrun and the mechanism, if any, for processing retries depend on the protocol specified by the Security Protocol field (see table 166) .

For Security Protocol field set to 00h, the format of the data is described in 7.59.6 . The format of the data for other Security Protocol values is specified by the group that owns the associated Security Protocol value.

Data transfer lengths for this command shall be non-zero multiples of 512 bytes . Pad bytes are appended as needed to meet this requirement . Pad bytes shall have a value of 00h.

The device shall retain data resulting from a TRUSTED SEND command awaiting retrieval by a TRUSTED RECEIVE command until one of the following events is processed:

   a) the data is delivered according to the Security Protocol field (see table 166) specific rules for the TRUSTED RECEIVE command;
   b) any reset; or
   c) loss of communication with the host that sent the TRUSTED SEND command.

7.59.3 Inputs

7.59.3.1 Overview

See table 165 for the TRUSTED RECEIVE command inputs.

Table 165 — TRUSTED RECEIVE command inputs

Name	Description
Feature	Security Protocol (see 7.59.3.2)
Count	Transfer Length (7:0) - See 7.59.3.4
LBA	**Bit Description** 27:24 Reserved 23:8 SP Specific (15:0) - Security Protocol Specific (see 7.59.3.3) 7:0 Transfer Length (15:8) - See 7.59.3.4
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 5Ch

7.59.3.2 Security Protocol

The Security Protocol field identifies which security protocol is being used . This determines the format of the SP Specific field and of the data that is transferred (see table 166) . If the Security Protocol field is set to a reserved value, the device shall return command aborted.

Table 166 — TRUSTED RECEIVE Security Protocol field description

Value	Description
00h	Return security protocol information (see 7.59.6)
01h..06h	Reserved for TCG
07h..1Fh	Reserved
20h	Reserved for T10
21h..ECh	Reserved
EDh	Defined by SDCard TrustedFlash Security Systems Specification 1.1.3
EEh	Defined by IEEE 1667
EFh	Reserved for T10
F0h..FFh	Vendor Specific.

7.59.3.3 SP Specific

The SP Specific field provides Security Protocol field specific information . The meaning of these fields are defined by each security protocol.

7.59.3.4 Transfer Length

The Transfer Length is security protocol specific

7.59.4 Normal outputs

See table 227.

7.59.5 Error outputs

The device shall return command aborted if an unrecoverable error occurred during the processing of the command . The amount of data transferred is indeterminate . A device may return command completion with the Error bit set to one if an Interface CRC error has occurred . See table 241.

7.59.6 Security Protocol 00h Description

7.59.6.1 Overview

The Security Protocol 00h returns basic information about the device . A TRUSTED RECEIVE command with Security Protocol field set to 00h is not linked to an earlier TRUSTED SEND command.

The Transfer Length field contains the number of 512-byte blocks of data to be transferred (e.g., one means 512 bytes, two means 1 024 bytes) . A transfer length of zero is invalid.

If the length of the TRUSTED RECEIVE parameter data is greater than the Transfer Length, then the device shall return the TRUSTED RECEIVE parameter data truncated to the requested Transfer Length .

When the Security Protocol field is set to 00h, the SP Specific field is shown in table 167.

Table 167 — Security Protocol 00h - SP Specific field descriptions for Protocol 00h

SP Specific	Description	Support
0000h	Return supported security protocol list (see 7.59.6.2)	Mandatory
0001h	Return a certificate (see 7.59.6.3)	Mandatory
0002h..FFFFh	Reserved	

If the SP Specific field is set to a reserved value, the command shall be aborted.

Each time a TRUSTED RECEIVE command with Security Protocol field set to 00h is received, the device shall transfer the data starting with byte 0.

7.59.6.2 Supported security protocols list description

When the Security Protocol field is set to 00h, and the SP Specific field is set to 0000h in a TRUSTED RECEIVE command, the parameter data shall have the format shown in table 168.

Table 168 — TRUSTED RECEIVE parameter data for SP Specific=0000h

Bit Byte	7	6	5	4	3	2	1	0
0	Reserved							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	List Length (M-7) bits (15:8)							
7	List Length (M-7) bits (7:0)							
8	Supported Security Protocol List							
M								
M+1	Pad bytes (if any)							
511								

The List Length field indicates the total length, in bytes, of the supported security protocol list.

The Supported Security Protocol List field shall contain a list of all supported Security Protocol field values . Each byte indicates a supported Security Protocol field value . The values shall be in ascending order starting with 00h.

The total data length shall be 512 bytes . Pad bytes are appended as needed to meet this requirement . Pad bytes shall have a value of 00h.

7.59.6.3 Certificate data description

7.59.6.3.1 Certificate overview

A certificate is either an X.509 Attribute Certificate (see 2.4) or an X.509 Public Key Certificate (see 2.4) depending on the capabilities of the device .

When the Security Protocol field of the TRUSTED RECEIVE command is set to 00h, and the SP Specific field is 0001h, the parameter data shall have the format shown in table 169.

Table 169 — TRUSTED RECEIVE parameter data for SP Specific=0001h

Bit Byte	7	6	5	4	3	2	1	0
0	Reserved							
1	Reserved							
2	(MSB)							
3		CERTIFICATE LENGTH (M - 3)						(LSB)
4	X.509 certificate bytes							
M								
M+1	Pad bytes (if any)							
511								

The CERTIFICATE LENGTH indicates the total length, in bytes, of the certificate(s) . This length includes one or more certificates . If the device has no certificate to return, then the certificate length is set to 0000h, the 4 byte header, and 508 pad bytes are returned.

The contents of the certificate fields are defined in 7.59.6.3.2 and 7.59.6.3.3.

The total data length shall conform to the Transfer Length field (see 7.59.3.4) requirements .

7.59.6.3.2 Public Key certificate description

RFC 3280 defines the certificate syntax for certificates consistent with the X.509v3 Public Key Certificate Specification.

7.59.6.3.3 Attribute certificate description

RFC 3281 defines the certificate syntax for certificates consistent with the X.509v2 Attribute Certificate Specification.

7.60 TRUSTED RECEIVE DMA - 5Dh, DMA

7.60.1 Feature Set

This 28-bit command is for devices implementing the Trusted Computing feature set (see 4.27).

7.60.2 Description

See 7.59.2.

7.60.3 Inputs

See table 170 for the TRUSTED RECEIVE DMA command inputs.

Table 170 — TRUSTED RECEIVE DMA command inputs

Name	Description
Feature	Security Protocol (see 7.59.3.2)
Count	Transfer Length (7:0) - See 7.59.3.4
LBA	**Bit Description** 27:24 Reserved 23:8 SP Specific (15:0) - Security Protocol Specific (see 7.59.3.3) 7:0 Transfer Length (15:8) - See 7.59.3.4
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 5Dh

See 7.59.3.

7.60.4 Normal Outputs

See 7.59.4.

7.60.5 Error Outputs

See 7.59.5.

7.61 TRUSTED SEND - 5Eh, PIO Data-Out

7.61.1 Feature Set

This 28-bit command is for devices implementing the Trusted Computing feature set (see 4.27).

7.61.2 Description

The TRUSTED SEND command sends one or more Security Protocol specific instructions to be processed by the device . The host uses TRUSTED RECEIVE commands to retrieve any data resulting from these instructions.

Any association between a TRUSTED SEND command and a subsequent TRUSTED RECEIVE command depends on the protocol specified by the Security Protocol field (see table 172) . Each protocol shall specify whether:

  a) the device shall complete the command without error as soon as the device determines the data has been received without error . An indication that the data has been processed is obtained by sending a TRUSTED RECEIVE command and receiving the results in the associated data transfer; or

  b) the device shall complete the command without error only after the data has been processed without error and an associated TRUSTED RECEIVE command is not required.

The completion of background activity resulting from a trusted command shall not return command aborted for any outstanding queued commands.

The format of the data and parameters depends on the protocol specified by the Security Protocol field (see table 172).

Data transfer lengths for this command shall be non-zero multiples of 512 bytes . Pad bytes are appended as needed to meet this requirement . Pad bytes shall have a value of 00h.

7.61.3 Inputs

7.61.3.1 Overview

See table 171 for the TRUSTED SEND command inputs.

Table 171 — TRUSTED SEND command inputs

Name	Description
Feature	Security Protocol (see 7.61.3.2)
Count	Transfer Length (7:0) - See 7.61.3.4
LBA	**Bit Description** 27:24 Reserved 23:8 SP Specific (15:0) - Security Protocol Specific (see 7.61.3.3) 7:0 Transfer Length (15:8) - See 7.61.3.4
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 5Eh

7.61.3.2 Security Protocol

The Security Protocol field identifies which security protocol is being used . This determines the format of the parameters and of the data that is transferred (see table 172) . If the Security Protocol field is set to a reserved value, the device shall return command aborted.

Table 172 — TRUSTED SEND - Security Protocol field description

Value	Description
00h	Reserved
01h..06h	Reserved for TCG
07h..1Fh	Reserved
20h	Reserved for T10
21h..ECh	Reserved
EDh	Reserved for SDCard
EEh	Reserved for IEEE 1667
EFh	Reserved for T10
F0h..FFh	Vendor Specific

7.61.3.3 SP Specific

The meaning of the security protocol-specific field is defined by each security protocol.

7.61.3.4 Transfer Length

The Transfer Length is security protocol specific.

7.61.4 Normal outputs

See table 227

7.61.5 Error outputs

The device shall return command aborted if an unrecoverable error occurred during the processing of the command . The amount of data transferred is indeterminate . A device may return command completion with the Error bit set to one if an Interface CRC error has occurred . See table 241.

7.62 TRUSTED SEND DMA - 5Fh, DMA

7.62.1 Feature Set

This 28-bit command is for devices implementing the Trusted Computing feature set (see 4.27).

7.62.2 Description

See 7.61.2.

7.62.3 Inputs

See table 173 for the TRUSTED SEND DMA command inputs.

Table 173 — TRUSTED SEND DMA command inputs

Name	Description
Feature	Security Protocol (see 7.61.3.2)
Count	Transfer Length (7:0) - See 7.61.3.4
LBA	**Bit Description** 27:24 Reserved 23:8 SP Specific (15:0) - Security Protocol Specific (see 7.61.3.3) 7:0 Transfer Length (15:8) - See 7.61.3.4
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 5Fh

See 7.61.3.

7.62.4 Normal Outputs

See 7.61.4.

7.62.5 Error Outputs

See 7.61.5.

7.63 WRITE BUFFER - E8h, PIO Data-Out

7.63.1 Feature Set

This 28-bit command is for ATA devices (see 4.2).

7.63.2 Description

The WRITE BUFFER command writes the contents of one 512-byte block of data to the device's buffer.

The READ BUFFER command and WRITE BUFFER command shall be synchronized within the device such that sequential WRITE BUFFER command and READ BUFFER command access the same bytes within the buffer .

7.63.3 Inputs

See table 174 for the WRITE BUFFER command inputs.

Table 174 — WRITE BUFFER command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 E8h

7.63.4 Normal Outputs

See table 215.

7.63.5 Error Outputs

A device may return command completion with the Error bit set to one if an Interface CRC error has occurred . See table 240.

7.64 WRITE BUFFER DMA - EBh, DMA

7.64.1 Feature Set

This 28-bit command is for ATA devices (see 4.2).

7.64.2 Description

See 7.63.2

7.64.3 Inputs

See table 175 for the WRITE BUFFER DMA command inputs.

Table 175 — WRITE BUFFER DMA command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 EBh

7.64.4 Normal Outputs

See 7.63.4.

7.64.5 Error Outputs

See 7.63.5.

7.65 WRITE DMA - CAh, DMA

7.65.1 Feature Set

This 28-bit command is for ATA devices (see 4.2).

7.65.2 Description

The WRITE DMA command writes data using the DMA data transfer protocol.

7.65.3 Inputs

See table 176 for the WRITE DMA command inputs.

Table 176 — WRITE DMA command inputs

Name	Description
Feature	N/A
Count	The number of logical sectors to be transferred . A value of 00h indicates that 256 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 CAh

7.65.4 Normal Outputs

See table 215.

7.65.5 Error Outputs

See table 265.

7.66 WRITE DMA EXT - 35h, DMA

7.66.1 Feature Set

This 48-bit command is for devices that implement the 48-bit Address feature set (see 4.4).

7.66.2 Description

The WRITE DMA EXT command writes data using the DMA data transfer protocol.

7.66.3 Inputs

See table 177 for the WRITE DMA EXT command inputs.

Table 177 — WRITE DMA EXT command inputs

Name	Description
Feature	Reserved
Count	The number of logical sectors to be transferred . A value of 0000h indicates that 65 536 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 35h

7.66.4 Normal Outputs

See table 227.

7.66.5 Error Outputs

See table 255.

7.67 WRITE DMA FUA EXT - 3Dh, DMA

7.67.1 Feature Set

This 48-bit command is for devices that implement the 48-bit Address feature set (see 4.4).

7.67.2 Description

The WRITE DMA FUA EXT command writes data using the DMA data transfer protocol and the user data shall be written to non-volatile media before command completion is reported regardless of whether or not volatile and/or non-volatile write caching in the device is enabled.

7.67.3 Inputs

See table 178 for the WRITE DMA FUA EXT command inputs.

Table 178 — WRITE DMA FUA EXT command inputs

Name	Description
Feature	Reserved
Count	The number of logical sectors to be transferred . A value of 0000h indicates that 65 536 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 3Dh

7.67.4 Normal Outputs

See table 227.

7.67.5 Error Outputs

See table 255.

7.68 WRITE FPDMA QUEUED - 61h, DMA Queued

7.68.1 Feature Set

This 48-bit command is for devices implementing the NCQ feature set (see 4.16).

7.68.2 Description

The WRITE FPDMA QUEUED command causes data to be transferred from the host to the device.

7.68.3 Inputs

7.68.3.1 Overview

See table 179 for the WRITE FPDMA QUEUED command inputs.

Table 179 — WRITE FPDMA QUEUED command inputs

Name	Description
Feature	The number of logical sectors to be transferred . A value of 0000h indicates that 65 536 logical sectors are to be transferred
Count	**Bit Description** 15 PRIO - See 7.29.3.2 14:8 Reserved 7:3 NCQ Tag - See 6.5.2 2:0 Reserved
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7 FUA - See 7.68.3.2 6 Shall be set to one 5 Reserved 4 Shall be set to zero 3:0 Reserved
Command	7:0 61h

7.68.3.2 Forced Unit Access (FUA)

When the FUA bit is set to one regardless of whether volatile and/or non-volatile write caching in the device is enabled or not, the user data shall be written to non-volatile media before command completion is reported . When the FUA bit is cleared to zero the device may return command completion before the data is written to the non-volatile media.

7.68.4 Command Acceptance Outputs

See table 231.

7.68.5 Normal Outputs

See table 232.

7.68.6 Error Outputs

If the Error bit is set to one, then the device aborted the command due to LBA out of range, a duplicate tag number, an invalid tag number, or an Interface CRC error, see table 270 for more information.

Errors that occur during the processing of this command are reported by returning a transport dependent indicator with additional information available in the NCQ Command Error log, see table 271 for more information.

7.69 WRITE LOG EXT - 3Fh, PIO Data-Out

7.69.1 Feature Set

This 48-bit command is for devices that implement the General Purpose Logging feature set (see 4.11).

7.69.2 Description

The WRITE LOG EXT command writes a specified number of 512 byte blocks of data to the specified log . See table A.2 for the list of logs.

7.69.3 Inputs

7.69.3.1 Overview

See table 180 for the WRITE LOG EXT command inputs.

Table 180 — WRITE LOG EXT command inputs

Name	Description
Feature	Reserved
Count	Log Page Count - See 7.69.3.2
LBA	**Bit Description** 47:40 Reserved 39:32 Page # (15:8) - See 7.69.3.3 31:16 Reserved 15:8 Page # (7:0) - See 7.69.3.3 7:0 Log Address - Specifies the log to be written as described in table A.2 . See 7.55.9.3.2
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 3Fh

7.69.3.2 Log Page Count

Specifies the number of log pages that shall be written to the specified log . If the number is zero, or the number is greater than the number indicated in the GPL Directory (see table A.3), the device shall return command aborted.

7.69.3.3 Page

Specifies the first page number to be written to the specified log address . Pages are numbered starting with zero.

7.69.4 Normal Outputs

See table 227 .

7.69.5 Error Outputs

A device shall return command aborted for the command if:

    a) the Count field is cleared to zero;
    b) the feature set associated with the log specified in the LBA field (7:0) is not supported or not enabled;
    c) the values in the Feature, Count, or LBA (47:8) fields are invalid;
    d) the host attempts to write to a read only log address; or
    e) the value in the Page # field plus the value in the Log Page Count field is larger than the log size reported in the GPL Directory (see A.2).

If the log data is not available or a data structure checksum error occurred, then the device shall return command completion for the command with the ID Not Found bit set to one.

A device may return command completion with the Error bit set to one if an Interface CRC error has occurred.

See table 253.

7.70 WRITE LOG DMA EXT - 57h, DMA

7.70.1 Feature Set

This 48-bit command is for devices implementing the General Purpose Logging feature set (see 4.11).

7.70.2 Description

See 7.69.2.

7.70.3 Inputs

See table 181 for the WRITE LOG DMA EXT command inputs.

Table 181 — WRITE LOG DMA EXT command inputs

Name	Description
Feature	Reserved
Count	Log Page Count - See 7.69.3.2
LBA	**Bit Description** 47:40 Reserved 39:32 Page # (15:8) - See 7.69.3.3 31:16 Reserved 15:8 Page # (7:0) - See 7.69.3.3 7:0 Log Address - Specifies the log to be written as described in table A.2 . See 7.55.9.3.2
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 57h

7.70.4 Normal Outputs

See 7.69.4.

7.70.5 Error Outputs

See 7.69.5.

7.71 WRITE MULTIPLE - C5h, PIO Data-Out

7.71.1 Feature Set

This 28-bit command is for ATA devices (see 4.2).

7.71.2 Description

The WRITE MULTIPLE command writes the number of logical sectors specified in the Count field.

The number of logical sectors per DRQ data block is defined by the content of IDENTIFY DEVICE data word 59 (see 7.18.7.21).

If the number of requested logical sectors is not evenly divisible by the DRQ data block count, as many full blocks as possible are transferred, followed by a final, partial block transfer.

Device errors encountered during WRITE MULTIPLE commands shall be returned after the attempted device write of the DRQ data block or partial DRQ data block is transferred . The command ends with the logical sector in error, even if the error was in the middle of a DRQ data block . Subsequent DRQ data blocks are not transferred in the event of an error.

The contents of the Command Structure following the transfer of a DRQ data block that had a logical sector in error are undefined . The host should retry the transfer as individual requests to obtain valid error information.

If IDENTIFY DEVICE data word 59 bit 8 is cleared to zero or IDENTIFY DEVICE data word 59 bits (7:0) (see 7.18.7.21) are set to zero, and a WRITE MULTIPLE command is received by the device, and no successful SET MULTIPLE MODE command has been processed by the device, the device shall return command aborted . A successful SET MULTIPLE MODE command should precede a WRITE MULTIPLE command.

7.71.3 Inputs

See table 182 for the WRITE MULTIPLE command inputs.

Table 182 — WRITE MULTIPLE command inputs

Name	Description
Feature	N/A
Count	The number of logical sectors to be transferred . A value of 00h indicates that 256 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 C5h

7.71.4 Normal Outputs

See table 215.

7.71.5 Error Outputs

If an unrecoverable error occurs while the device is processing this command, then the device shall return command completion with the Error bit set to one and the LBA field set to the LBA of the logical sector where the first unrecoverable error occurred . The amount of data transferred is indeterminate . A device may return command completion with the Error bit set to one if an Interface CRC error has occurred . See table 264.

7.72 WRITE MULTIPLE EXT - 39h, PIO Data-Out

7.72.1 Feature Set

This 48-bit command is for devices that implement the 48-bit Address feature set (see 4.4).

7.72.2 Description

The WRITE MULTIPLE EXT command writes the number of logical sectors specified in the Count field.

The number of logical sectors per DRQ data block is defined by the content of IDENTIFY DEVICE data word 59 (see 7.18.7.21).

If the number of requested logical sectors is not evenly divisible by the DRQ data block count, as many full blocks as possible are transferred, followed by a final, partial block transfer.

Device errors encountered during WRITE MULTIPLE EXT commands shall be returned after the attempted write of the DRQ data block or partial DRQ data block is transferred . The command ends with the logical sector in error, even if the error was in the middle of a DRQ data block . Subsequent DRQ data blocks are not transferred in the event of an error.

The contents of the Command Structure following the transfer of a data block that had a logical sector in error are undefined . The host should retry the transfer as individual requests to obtain valid error information.

If IDENTIFY DEVICE data word 59 bit 8 (see 7.18.7.21) is cleared to zero or IDENTIFY DEVICE data word 59 bits (7:0) (see 7.18.7.21) are set to zero, and a WRITE MULTIPLE EXT command is received by the device, and no successful SET MULTIPLE MODE command has been processed by the device, the device shall return command aborted . A successful SET MULTIPLE MODE command should precede a WRITE MULTIPLE EXT command.

7.72.3 Inputs

See table 183 for the WRITE MULTIPLE EXT command inputs.

Table 183 — WRITE MULTIPLE EXT command inputs

Name	Description
Feature	Reserved
Count	The number of logical sectors to be transferred . A value of 0000h indicates that 65 536 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 39h

7.72.4 Normal Outputs

See table 227.

7.72.5 Error Outputs

If an unrecoverable error occurs while the device is processing this command, then the device shall return command completion with the Error bit set to one and the LBA field set to the LBA of the logical sector where the

first unrecoverable error occurred . The amount of data transferred is indeterminate . A device may return command completion with the Error bit set to one if an Interface CRC error has occurred . See table 255.

7.73 WRITE MULTIPLE FUA EXT - CEh, PIO Data-Out

7.73.1 Feature Set

This 48-bit command is for devices that implement the 48-bit Address feature set (see 4.4).

7.73.2 Description

The WRITE MULTIPLE FUA EXT command writes the number of logical sectors specified in the Count field . The user data shall be written to non-volatile media before command completion is reported regardless of whether or not volatile and/or non-volatile write caching in the device is enabled.

The number of logical sectors per DRQ data block is defined by the content of IDENTIFY DEVICE data word 59 (see 7.18.7.21).

If the number of requested logical sectors is not evenly divisible by the DRQ data block count, as many full blocks as possible are transferred, followed by a final, partial block transfer.

Device errors encountered during WRITE MULTIPLE EXT commands shall be returned after the attempted write of the DRQ data block or partial DRQ data block is transferred . The command ends with the logical sector in error, even if the error was in the middle of a DRQ data block . Subsequent DRQ data blocks are not transferred in the event of an error.

The contents of the Command Structure following the transfer of a data block that had a logical sector in error are undefined . The host should retry the transfer as individual requests to obtain valid error information.

If IDENTIFY DEVICE data word 59 bit 8 (see 7.18.7.21) is cleared to zero or IDENTIFY DEVICE data word 59 bits (7:0) (see 7.18.7.21) are set to zero, and a WRITE MULTIPLE FUA EXT command is received by the device, and no successful SET MULTIPLE MODE command has been processed by the device, the device shall return command aborted . A successful SET MULTIPLE MODE command should precede a WRITE MULTIPLE FUA EXT command.

7.73.3 Inputs

See table 184 for the WRITE MULTIPLE FUA EXT command inputs.

Table 184 — WRITE MULTIPLE FUA EXT command inputs

Name	Description
Feature	Reserved
Count	The number of logical sectors to be transferred . A value of 0000h indicates that 65 536 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred

Device	**Bit Description**
	
	  7 Obsolete
	
	  6 Shall be set to one
	
	  5 Obsolete
	
	  4 Transport Dependent - See 6.2.12
	
	  3:0 Reserved

Command	7:0 CEh

7.73.4 Normal Outputs

See table 227.

7.73.5 Error Outputs

If an unrecoverable error occurs while the device is processing this command, then the device shall return command completion with the Error bit set to one and the LBA field set to the LBA of the logical sector where the first unrecoverable error occurred . The amount of data transferred is indeterminate . A device may return command completion with the Error bit set to one if an Interface CRC error has occurred . See table 255.

7.74 WRITE SECTOR(S) - 30h, PIO Data-Out

7.74.1 Feature Set

This 28-bit command is for ATA devices (see 4.2).

7.74.2 Description

The WRITE SECTOR(S) command writes from 1 to 256 logical sectors as specified in the Count field.

7.74.3 Inputs

See table 185 for the WRITE SECTOR(S) command inputs.

Table 185 — WRITE SECTOR(S) command inputs

Name	Description
Feature	N/A
Count	The number of logical sectors to be transferred . A value of 00h indicates that 256 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 30h

7.74.4 Normal Outputs

See table 215.

7.74.5 Error Outputs

If an unrecoverable error occurs while the device is processing this command, then the device shall return command completion with the Error bit set to one and the LBA field set to the LBA of the logical sector where the first unrecoverable error occurred . The amount of data transferred is indeterminate . A device may return command completion with the Error bit set to one if an Interface CRC error has occurred . See table 264.

7.75 WRITE SECTOR(S) EXT - 34h, PIO Data-Out

7.75.1 Feature Set

This 48-bit command is for devices that implement the 48-bit Address feature set (see 4.4).

7.75.2 Description

The WRITE SECTOR(S) EXT command writes from 1 to 65 536 logical sectors as specified in the Count field.

7.75.3 Inputs

See table 186 for the WRITE SECTOR(S) EXT command inputs.

Table 186 — WRITE SECTOR(S) EXT command inputs

Name	Description
Feature	Reserved
Count	The number of logical sectors to be transferred . A value of 0000h indicates that 65 536 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 34h

7.75.4 Normal Outputs

See table 227.

7.75.5 Error Outputs

If an unrecoverable error occurs while the device is processing this command, then the device shall return command completion with the Error bit set to one and the LBA field set to the LBA of the logical sector where the first unrecoverable error occurred . The amount of data transferred is indeterminate . A device may return command completion with the Error bit set to one if an Interface CRC error has occurred . See table 255.

7.76 WRITE STREAM DMA EXT - 3Ah, DMA

7.76.1 Feature Set

This 48-bit command is for devices that implement the Streaming feature set (see 4.26).

7.76.2 Description

The WRITE STREAM DMA EXT command writes data within an allotted time . This command specifies that additional actions are to be performed by the device prior to the completion of the command.

7.76.3 Inputs

7.76.3.1 Inputs overview

See table 187 for the WRITE STREAM DMA EXT command inputs.

Table 187 — WRITE STREAM DMA EXT command inputs

Name	Description
Feature	**Bit** **Description** 15:8 Command Completion Time Limit (CCTL) - See 7.38.3.2. 7 Obsolete 6 Write Continuous (WC) - See 7.76.3.2 5 Flush - See 7.76.3.3 4 Obsolete 3 Reserved 2:0 Stream ID – See 7.76.3.4
Count	The number of logical sectors to be transferred . A value of 0000h indicates that 65 536 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit** **Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 3Ah

7.76.3.2 Write Continuous (WC)

The WC bit specifies whether the Write Continuous mode is enabled or disabled.

If the WC bit is set to one, then:

   a) the device shall not stop processing the command due to errors;
   b) if an error occurs during data transfer or while writing data to media before command completion or before the amount of time allowed for command completion based on the setting of CCTL (see 7.38.3.2) or Default CCTL (see 7.9.3) is reached, then the device:
      1) shall continue to transfer the amount of data requested;
      2) may continue writing data to the media;

    3) shall report command completion after all data for the command has been transferred; and
    4) shall save the error information in the Write Streaming Error log (see A.18);

    or

  c) if the amount of time allowed for command completion based on the setting of the CCTL field
    (see 7.38.3.2) or Default CCTL (see 7.9.3) is reached, then the device:
    1) shall stop processing the command;
    2) shall report command completion;
    3) shall set the Command Completion Time Out bit in the Write Streaming Error log to one; and
    4) may continue writing data to the media.

If the WC bit is cleared to zero and an error occurs, then the device:

  a) shall stop processing the command and report command completion; and
  b) may continue writing data to the media.

7.76.3.3 Flush

If the Flush bit is set to one, the Default CCTL field is set to zero, and the CCTL field is cleared to zero, then the device shall write all data for the specified stream to the media before command completion is reported.

If the Flush bit is set to one and the Default CCTL field was not set to zero in the most recent CONFIGURE STREAM command (see 7.9) for the Stream ID, then the device shall report command completion within the time specified by the Default CCTL field (see 7.9.3.4).

If the Flush bit is set to one and the CCTL field is not set to zero, then the device shall report command completion within (CCTL * (IDENTIFY DEVICE data words 98..99 (see 7.18.7.52)) μs.

If the Flush bit is set to one and either the Default CCTL field was not set to zero in the most recent CONFIGURE STREAM command (see 7.9) for the Stream ID, or the CCTL field is not set to zero, then the device:

  a) shall measure the time before reporting command completion from command acceptance;
  b) shall set the Command Completion Time Out (see 6.3.4) to one if all of the data for the command has
    been received by the device, but the device has not yet written all of the data to its media; and
  c) should continue writing data to its media after reporting command completion.

7.76.3.4 Stream ID

The Stream ID field specifies the stream to be written . The device shall operate according to the parameters specified by the most recent successful CONFIGURE STREAM command specifying this Stream ID . Any write to the device media or internal device buffer management as a result of the Stream ID is vendor specific.

7.76.4 Normal Outputs

See table 220 for the definition of Normal Outputs.

7.76.5 Error Outputs

If:

  a) The WC bit was set to one in the command; and
  b) the device is able to accept the amount of data requested for the command (e.g., an error occurred while
    writing to the media),

then the device shall set the Stream Error bit to one and clear the Error bit to zero.

If:

  a) The WC bit was set to one in the command; and
  b) the device is not able to return the amount of data requested for the command (e.g., an Interface CRC
    error shall be reported at command completion),

then the device shall clear the Stream Error bit to zero and set the Error bit to one.

If:

  a) The WC bit was cleared to zero in the command;

   b) The CCTL field was not set to zero in the command, or the CCTL field was cleared to zero in the
       command and the Default CCTL field specified in the most recent CONFIGURE STREAM command
       (see 7.9) for the Stream ID field was not cleared to zero; and
   c) the time specified for command completion by the CCTL field (see 7.38.3.2) or the Default CCTL
       (see 7.9.3) has been reached,

then the device shall clear the Stream Error bit to zero, set the Error bit to one, and set the Abort bit to one
whether or not all data has been flushed to media.

If:

   a) the WC bit was cleared to zero in the command;
   b) the CCTL field was set to zero in the command; and
   c) the Default CCTL field was set to zero in the most recent CONFIGURE STREAM command (see 7.9) for
       the Stream ID field,

then the device shall clear the Stream Error bit to zero, set the Error bit to one, and set the Interface CRC bit, ID
Not Found bit, and/or Abort bit to one (i.e., indicating the error type).

A device may return command completion with the Error bit set to one if an Interface CRC error has occurred .
See table 256.

7.77 WRITE STREAM EXT - 3Bh, PIO Data-Out

7.77.1 Feature Set

This 48-bit command is for devices that implement the Streaming feature set (see 4.26).

7.77.2 Description

See 7.76.2.

7.77.3 Inputs

See table 188 for the WRITE STREAM EXT command inputs.

Table 188 — WRITE STREAM EXT command inputs

Name	Description
Feature	**Bit Description** 15:8 Command Completion Time Limit (CCTL) - See 7.38.3.2. 7 Obsolete 6 Write Continuous (WC) - See 7.76.3.2 5 Flush - See 7.76.3.3 4 Obsolete 3 Reserved 2:0 Stream ID – See 7.76.3.4
Count	The number of logical sectors to be transferred . A value of 0000h indicates that 65 536 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 3Bh

7.77.4 Normal Outputs

See 7.76.4.

7.77.5 Error Outputs

See 7.76.5.

7.78 WRITE UNCORRECTABLE EXT - 45h, Non-Data

7.78.1 Feature Set

This 48-bit command is for ATA devices (see 4.2) and prohibited for ATAPI devices (see 4.3) . The WRITE UNCORRECTABLE EXT command is not part of any feature set.

7.78.2 Description

7.78.2.1 Overview

The WRITE UNCORRECTABLE EXT command causes the device to report an uncorrectable error when the specified logical sectors are subsequently read.

When the device processes a read command, it shall set the Uncorrectable Error bit to one and the Error bit to one when a pseudo uncorrectable or flagged uncorrectable logical sector is read . Reading a flagged or pseudo uncorrectable logical sector may affect the Number of Reallocated Logical Sectors device statistic (see A.5.6.6).

If the device completes a write command to a pseudo uncorrectable logical sector or flagged uncorrectable logical sector without error, then the device:

a) shall write the data to the logical sector;
b) shall only cause the specified logical sectors to become valid; and
c) shall not cause any other logical sectors (e.g., other logical sectors in the same physical sector) to become valid.
d) shall clear the pseudo uncorrectable attribute or flagged uncorrectable attribute of the logical sector; and
e) should verify that the logical sector may now be read without error.

The pseudo uncorrectable attribute or flagged uncorrectable attribute of a logical sector shall remain set during the processing of all power and reset events . If the device is unable to process a WRITE UNCORRECTABLE EXT command for any reason the device shall return command aborted.

7.78.2.2 Pseudo Uncorrectable Logical Sectors

When the Feature field (7:0) contains a value of 55h the WRITE UNCORRECTABLE EXT command shall cause the device to indicate a failure when reads to any of the logical sectors that are contained in the physical block of the specified logical sector are performed . These logical sectors are referred to as pseudo uncorrectable logical sectors . Whenever a pseudo uncorrectable logical sector is accessed via a read command the device shall perform normal error recovery to the fullest extent until:

a) the error recovery process is completed the Uncorrectable Error bit is set to one, and the Error bit is set to one; or
b) a command time-out that applies to error recovery control occurs before error recovery is completed and an error is reported as a result of the command time-out (see 8.3.3).

When reading a pseudo uncorrectable logical sector, the device shall perform error logging (e.g., SMART, device statistics) in the same manner as an Uncorrectable error.

7.78.2.3 Flagged Uncorrectable Logical Sectors

When the Feature field (7:0) contains a value of AAh the WRITE UNCORRECTABLE EXT command shall cause the device to flag the specified logical sectors as flagged uncorrectable . Flagging a logical sector as uncorrectable shall cause the device to indicate a failure when reads to the specified logical sector are processed . When reading a flagged uncorrectable logical sector, the device should not perform error logging (e.g., SMART, device statistics) in the same manner as an Uncorrectable error.

7.78.3 Inputs

See table 189 for the WRITE UNCORRECTABLE EXT command inputs.

Table 189 — WRITE UNCORRECTABLE EXT command inputs

Name	Description

Feature	**Bit Description**
	
	15:8 Reserved
	
	7:0 Uncorrectable options
	
	       Value Description
	
	   00h-54h Reserved
	
	       55h Create a pseudo-uncorrectable error with logging
	
	   56h-59h Reserved
	
	       5Ah Vendor specific
	
	   5Bh-A4h Reserved
	
	       A5h Vendor Specific
	
	   A6h-A9h Reserved
	
	       AAh Create a flagged error without logging
	
	   ABh-FFh Reserved

Count	The number of logical sectors to be marked . A value of 0000h indicates that 65 536 logical sectors are to be marked
LBA	LBA of first logical sector to be marked
Device	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 45h

7.78.4 Normal Outputs

See table 215.

7.78.5 Error Outputs

See table 239.

8 SCT Command Transport

8.1 Introduction

8.1.1 Overview

The SCT Command Transport provides a method for a host to send commands and data to a device and for a device to send data and status to a host using logs . Log Address E0h (i.e., SCT Command/Status) (see 8.2.3 and 8.2.5) is used to issue commands and return status . Log Address E1h (i.e., SCT Data Transfer) (see 8.2.4) is used to transport data.

The following methods are used to access the logs defined for the SCT Command Transport:

    a) using the SMART READ LOG command and SMART WRITE LOG command; and
    b) using READ LOG (DMA) EXT command and WRITE LOG (DMA) EXT command.

These sets of commands access the same logs and provide the same capabilities . The two methods are also used in the same way (e.g., a command is issued, data is transferred, if necessary, and status may be retrieved multiple times).

If the SMART feature set (see 4.23) is supported and not enabled, then a device that implements this feature set shall support the SMART READ LOG command and SMART WRITE LOG command to the SCT Command/Status log and the SCT Data Transfer log.

Sending a key 512-byte block of data (i.e., key data block) to the SCT Command/Status log starts the command process . The key data block specifies an Action Code and Function Code along with the parameters that are required to process the action . The SCT command response (i.e., error or command) is the same for both methods of issuing commands.

SCT commands are processed like other ATA commands, therefore they take precedence over any background activity the device may be performing when the SCT command is issued (i.e., a function initiated by a SMART EXECUTE OFFLINE IMMEDIATE command) . Some SCT commands indicate command completion and return status while the SCT command is still processing.

A device supporting the SCT Command Transport should report a length of one in the General Purpose Log Directory (see A.2) and the SMART Log Directory (see A.3) for the SCT Command/Status log and the SCT Data Transfer log . The length of the SCT Data Transfer log does not indicate the length of an SCT Command Transport data transfer . This differs from the requirement in this standard that the GPL Directory and the SMART Log Directory report the actual length of the specified log pages.

8.1.2 SCT command nesting and interspersing with standard commands

Standard ATA commands may be interspersed with some SCT commands, but SCT commands shall not be nested . If an SCT command has not completed processing and another SCT command is received by the device (i.e., the host writes the SCT command/status log), then the first SCT command shall be aborted and the new SCT command shall be processed . SCT commands that do not require a subsequent data transfer operation are not interspersed with any ATA commands or each other . SCT commands that require data transfer shall not be nested (i.e., if the device receives another SCT command before all available data is transferred, then the device shall abort the current SCT operation and process the new SCT command without reporting an error).

8.1.3 Resets

A device shall terminate processing an SCT command during the processing of a software reset, hardware reset, or power-on reset . This may result in partial command processing or data loss . There is no indication once the device becomes ready that the previous command was terminated.

A device shall clear the SCT Status Response fields (i.e., Extended Status Code, Action Code, and Function Code) during the processing of a power-on reset and a hardware reset . A device shall clear the Extended status code during processing of a software reset and the other content of the SCT Status Response fields shall not be affected by the device processing the reset.

8.2 Processing SCT commands

8.2.1 Processing SCT commands overview

The following phases are required to process SCT commands:

1) Capability identification (see 8.2.2);
2) SCT Command transfer (see 8.2.3);
3) Data transfer (see 8.2.4); and
4) Status (see 8.2.5).

8.2.2 SCT capability identification

IDENTIFY DEVICE data word 206 indicates support for the SCT Command Transport and SCT commands (see 7.18.7.75).

8.2.3 SCT command transfer

Transfer of an SCT command occurs when a 512-byte data packet is written to the SCT Command/Status log (see A.1) . The 512-byte data packet contains a single command as defined in the SCT Command Transport.

Table 190 defines the SCT command format, contained in the input data of the SMART WRITE LOG command (see 7.55.9).

Table 190 — Fields to issue an SCT command using SMART WRITE LOG

Name	Description
Feature	D6h (i.e., SMART WRITE LOG)
Count	01h
LBA	**Bit** **Description** 27:24 N/A 23:8 C24Fh 7:0 E0h (i.e., SCT Command/Status log address)
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B0h

Table 191 defines the SCT command format, contained in the input data of the WRITE LOG (DMA) EXT command (see 7.69).

Table 191 — Fields to issue an SCT command using WRITE LOG (DMA) EXT

Name	Description
Feature	Reserved
Count	0001h
LBA	**Bit Description** 47:40 Reserved 39:32 00h 31:16 Reserved 15:8 00h 7:0 E0h (i.e., SCT Command/Status log address)
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 3Fh (i.e., WRITE LOG EXT) 57h (i.e., WRITE LOG DMA EXT)

Table 192 defines how a device shall set the fields after successful completion of an SCT command.

Table 192 — Successful SCT command response

Name	Description
Error	00h
Count	SCT Command Dependent Data
LBA	SCT Command Dependent Data
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5:1 N/A 0 Error - See 6.2.9

Table 193 defines how a device shall set the fields after an error occurred during processing of an SCT command.

Table 193 — SCT command error response

Name	Description
Error	**Bit Description** 7:5 N/A 4 ID Not Found - See 6.3.6 . 3 N/A 2 Abort - See 6.3.2. 1 N/A 0 Obsolete
Count	Extended Status Code (7:0) (see table 194)
LBA	**Bit Description** 27:24 Reserved 23:8 SCT Command dependent. 7:0 Extended Status Code (15:8) (see table 194)
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5:1 N/A 0 Error - See 6.2.9

Table 194 — Extended Status codes

Extended Status Code	Description
0000h	Command complete without error
0001h	Invalid Function Code
0002h	Input LBA out of range
0003h	Request 512-byte data block count overflow . The number of data blocks requested to transfer (Count field) in the log command is larger than specified by the SCT command
0004h	Invalid Function code in Error Recovery command
0005h	Invalid Selection code in Error Recovery command
0006h	Host read command timer is less than minimum value
0007h	Host write command timer is less than minimum value
0008h	Background SCT command was aborted because of an interrupting host command
0009h	Background SCT command was terminated because of unrecoverable error
000Ah	Obsolete
000Bh	SCT data transfer command was issued without first issuing an SCT command
000Ch	Invalid Function code in SCT Feature Control command
000Dh	Invalid Feature code in SCT Feature Control command
000Eh	Invalid New State value in SCT Feature Control command
000Fh	Invalid Option Flags value in SCT Feature Control command
0010h	Invalid SCT Action code
0011h	Invalid Table ID (table not supported)
0012h	Command was aborted due to device security being locked
0013h	Invalid revision code in SCT data
0014h	Foreground SCT operation was terminated because of unrecoverable error
0015h	The most recent non-SCT command completed with an error due to the SCT Error Recovery Control Read Command Timer or SCT Error Recovery Control Write Command Timer expiring.
0016h-BEFFh	Reserved
BF00h-BFFFh	Reserved for Serial ATA
C000h-FFEFh	Vendor specific
FFF0h-FFFEh	Reserved
FFFFh	SCT command executing in background

8.2.4 SCT data transfer

Once an SCT command for a data transfer has been issued, status is checked and data is transferred using the SCT Data Transfer log (see A.1) . Up to 255 data blocks of 512-bytes each may be transferred at a time . If the SCT command requires more than 255 blocks of data transfer and SMART READ LOG commands and SMART WRITE LOG commands are used to transfer the data, then the data may be written or read in up to 255 data block increments . If GPL feature set (see 4.11) commands are used to transfer data, then up to 65 535 data blocks of 512-bytes each may be transferred by a single command . If more than 65 535 data blocks are required, then multiple GPL feature set commands may be issued . Table 195 shows how to perform an SCT data transfer using a SMART READ LOG command (see 7.55.7) or SMART WRITE LOG command (see 7.55.9).

Table 195 — SCT data transfer using SMART READ LOG or SMART WRITE LOG

Name	Description
Feature	D6h (i.e., SMART WRITE LOG) D5h (i.e., SMART READ LOG)
Count	Number of 512-byte data blocks to transfer
LBA	**Bit Description** 27:24 N/A 23:8 C24Fh 7:0 E1h (i.e., SCT Data Transfer)
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B0h

Table 196 defines the fields for data transfer using a GPL feature set (see 4.11)command.

Table 196 — SCT data transfer using the GPL feature set

Name	Description
Feature	Reserved
Count	Number of 512-byte data blocks to transfer
LBA	**Bit** **Description** 47:40 Reserved 39:32 00h 31:16 Reserved 15:8 00h 7:0 E1h (i.e., SCT Data Transfer)
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 2Fh (i.e., READ LOG EXT) 47h (i.e., READ LOG DMA EXT) 3Fh (i.e., WRITE LOG EXT) 57h (i.e., WRITE LOG DMA EXT)

8.2.5 SCT status

Status for an SCT command may be read at any time by reading the SCT Command/Status log (see A.1) . If the command involves data transfer, the host should check status before data is transferred to ensure that the device is ready . The host should also check status when the command is complete to confirm that the data was transferred without error . When the command is complete, the host may check status a third time to determine if the command succeeded, failed, or partially succeeded.

Once an SCT command has been issued, status is reported in the ATA fields . This status indicates that the command was accepted or that an error occurred . This ATA status return does not indicate successful completion of the SCT actions, except foreground SCT Write Same commands (see 8.3.2) that require the completion of the SCT action (i.e., SCT Write Same with function code 0101h and 0102h) . Some commands may take several minutes or even hours to process . The host may determine processing progress by requesting SCT status . Some commands may require setup time before a device is ready to receive data . SCT status indicates when the device is ready to receive data.

Reading the SCT Command/Status log retrieves the status information . The SCT status may be acquired any time that the host is allowed to send a command to the device . This command shall not change the power state of the device, nor terminate any background activity, including any SCT command in progress (i.e., . if the device is in the Standby state or Idle state (see 4.19.4), then the log request shall succeed).

Table 197 defines shows how to get the SCT status using a SMART READ LOG command (see 7.55.7).

Table 197 — SCT status request using SMART READ LOG

Name	Description
Feature	D5h (i.e., SMART READ LOG)
Count	01h
LBA	**Bit Description** 27:24 N/A 23:8 C24Fh 7:0 E0h (i.e., SCT Command/Status log address)
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B0h

Table 198 defines the fields for retrieving status using a READ LOG EXT command (see 7.30) or READ LOG DMA EXT command (see 7.31).

Table 198 — SCT status request using the GPL feature set

Name	Description
Feature	Reserved
Count	0001h
LBA	**Bit Description** 47:40 Reserved 39:32 00h 31:16 Reserved 15:8 00h 7:0 E0h (i.e., SCT Command/Status log address)
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 2Fh (i.e., READ LOG EXT) 47h (i.e., READ LOG DMA EXT)

Table 199 defines the format of the status response information that shall be set by the device in the SCT Command/Status log.

Table 199 — Format of SCT status response (part 1 of 2)

Offset	Type	Field Name	Description
0..1	Word	Format Version	0003h - Status Response format version number.
2..3	Word	SCT Version	Manufacturer's vendor specific implementation version number
4..5	Word	SCT Spec.	Obsolete
6..9	DWord	Status Flags	Bits (31:1) - Reserved Bit 0 - Segment Initialized Flag . If this bit is set to one, then an SCT Write Same command (see 8.3.2) to all logical blocks has completed without error . This bit shall be cleared to zero when any user LBA is written, even if write cache is enabled . This bit shall also be cleared to zero if the capacity of the device is changed via a SET MAX ADDRESS command (see 7.51.2), SET MAX ADDRESS EXT command (see 7.52), DEVICE CONFIGURATION SET DMA command (see 7.11.7), or DEVICE CONFIGURATION SET command (see 7.11.6) . This bit is preserved during the processing of all power and reset events.

Table 199 — Format of SCT status response (part 2 of 2)

Offset	Type	Field Name	Description
10	Byte	Device State	00h - Active waiting for a command 01h - Stand-by 02h - Sleep 03h - DST processing in background 04h - SMART Off-line Data Collection processing in background 05h - SCT command processing in background 06h-FFh - Reserved
11..13	Byte [3]	reserved	
14..15	Word	Extended Status Code	Status of last SCT command issued . FFFFh if SCT command processing in background (see table 194).
16..17	Word	Action Code	Action code of last SCT command issued . If the Extended Status Code is FFFFh this is the Action Code of the command that is currently processing.
18..19	Word	Function Code	Function code of last SCT command issued . If the Extended Status Code is FFFFh this is the Function Code of the command that is currently processing.
20..39	Byte [20]	reserved	
40..47	QWord	LBA	Current LBA of SCT command processing in background . If there is no command currently processing in the background, this field is undefined.
48..199	Byte [152]	reserved	
200	Byte	HDA Temp	Current device temperature in degrees Celsius . This is a two's complement integer . 80h indicates that this value is invalid.
201	Byte	Min Temp	Minimum temperature in degrees Celsius since the last power-on event . This is a two's complement integer . 80h indicates that this value is invalid.
202	Byte	Max Temp	Maximum temperature in degrees Celsius since the last power-on event . This is a two's complement integer . 80h indicates that this value is invalid.
203	Byte	Life Min Temp	Minimum temperature in degrees Celsius seen for the life of the device . This is a two's complement integer . 80h indicates that this value is invalid.
204	Byte	Life Max Temp	Maximum temperature in degrees Celsius seen for the life of the device . This is a two's complement integer . 80h indicates that this value is invalid.
205	Byte	reserved	
206..209	DWord	Over Limit Count	Number of temperature recording intervals since the last power-on reset where the recorded temperature was greater than Max Op Limit . See table 211 for information about this interval.
210..213	DWord	Under Limit Count	Number of temperature recording intervals since the last power-on reset where the recorded temperature was less than Min Op Limit . See table 211 for information about this interval.
214..479	Byte [266]	reserved	
480..511	Byte [32]	Vendor Specific	

8.3 SCT Command Set

8.3.1 Overview

An SCT command shall be 512 bytes long . While an SCT command is being processed a host may use an SCT status request to retrieve status information (e.g., to determine if a command is active or complete, the current LBA, or error information) about the current SCT command.

Table 200 defines the format of an SCT command written to the SCT Command/Status log (see A.1).

Table 200 — SCT command format

Offset	Field	Words	Description
0..1	Action Code	1	This field specifies the command type and the type of data being accessed, or the action being performed . (See table 201 for definition of the Action Code field contents.)
2..3	Function Code	1	This field specifies the type of access and varies by command.
4..x	Parameter1	Depends on command	Depends on command
x+1..y	Parameter2	Depends on command	Depends on command
…	...	...	...
	Total Words	256	

Table 201 — SCT Action Codes

Action Code	Description
0000h	Reserved
0001h	Obsolete
0002h	SCT Write Same command (see 8.3.2)
0003h	SCT Error Recovery Control command (see 8.3.3)
0004h	SCT Feature Control command (see 8.3.4)
0005h	SCT Data Tables command (see 8.3.5)
0006h	Vendor specific
0007h	Reserved for Serial ATA
0008h-BFFFh	Reserved
C000h-FFFFh	Vendor specific

8.3.2 SCT Write Same command

The SCT Write Same command specifies that the device shall write a specific pattern to its media.

The SCT Write Same command shall cause the device to begin writing logical sectors from the first logical sector specified by the Start field (see table 202) in incrementing order until the number of logical sectors specified by the Count field (see table 202) have been written . If the Count field contains all zeros, then the device shall write all logical sectors beginning with the logical sector specified by the Start field through the last LBA of the user data area on the device . If the HPA feature (see 4.12) set is implemented by the device and the HPA feature set is enabled, then this feature set shall determine the last user addressable logical sector (see 4.12.4) . This command shall not write over a hidden partition when hidden partitions are enabled using the HPA feature set (see 4.12) . Automatic sector reallocation is permitted during the processing of this SCT command.

If the Start field or the Start field plus the Count field specify an LBA greater than the last user addressable logical sector (see 4.12.4), then the device shall report an error and return command aborted . If the Start field and the Count field contain zero, then the device shall write the specified pattern to all user addressable logical sectors (see 4.12.4) on the device.

Any new command other than an SCT status request (e.g., IDENTIFY DEVICE command (see 7.18)), received by the device while this command is in progress shall terminate this command and the device shall process the new command.

While an SCT Write Same command with function code 0001h or function code 0002h is processed as a background activity, the SCT status error code shall be set to FFFFh . If the background activity completes without error, then the SCT status error code shall be set to 0000h . If any error occurs during the background activity, then the SCT status error code shall be set to a value less than FFFFh and greater than 0000h.

Once the key data block (see 8.1.1) has been issued, if the Function Code was 0002h and the input data structure indicates that the device is ready to receive data, the SCT Data Transfer log (see A.1) should be written to transfer the data .

For the SCT Write Same command with function code 0101h the Command Completion Status of the write to the SCT Command/Status log (see A.1) shall indicate the success or failure of this command . For the SCT Write Same command with function Code 0102h the Command Completion Status of the write to the SCT Data Transfer log shall indicate the success or failure of this command . The Status and Error fields indicate the status/error values as defined in clause 6 . In the case of an error an SCT Status Request may be made by reading the SCT Command/Status log (see A.1) to obtain a more detailed analysis of the error.

This command may change the Segment Initialized Flag (see table 199) . If this command writes all of the user data area and completes without an error or being aborted, then the Segment Initialized Flag (i.e., bit 0 of the Status Flags in the SCT status) shall be set to one . A write within the user data area on the device, except one caused by another SCT Write Same command with the Start field and the Count field set to zero (i.e., an SCT Write Same command causing the device to write to all of the user data area), shall cause the Segment Initialized Flag to be cleared . Reallocations as a result of reading data, either in the foreground or background, shall not clear the Device Zeroed flag.

Table 202 defines the format of a SCT Write Same command written to the SCT Command/Status log (see A.1).

Table 202 — SCT Write Same command

Word	Name	Value	Description
0	Action Code	0002h	This action writes a pattern or 512-byte data block repeatedly to the media.
1	Function Code	0000h	Reserved
		0001h	Repeat write pattern
		0002h	Repeat write data block
		0003h-0100h	Reserved
		0101h	Repeat write pattern foreground
		0102h	Repeat write data block foreground
		0103h-FFFFh	Reserved
2..5	Start	QWord	First logical sector to write
			63:48 Reserved
			47:0 First LBA
6..9	Count	QWord	Number of logical sectors to fill
10..11	Pattern	DWord	If the Function Code is 0001h or 0101h, this field contains a 32-bit pattern that is written on the media starting at the location specified in words 2..5.

Table 203 defines the format of the status response for a SCT Write Same command.

Table 203 — SCT Write Same command status response

Name	Description
Error	**Bit Description** 7:5 N/A 4 ID Not Found - See 6.3.6 . 3 N/A 2 Abort - See 6.3.2. 1 N/A 0 Obsolete
Count	Reserved
LBA	**Bit Description** 27:24 Reserved 23:8 0000h – If FC=0001h or FC=0101h 0001h – If FC=0002h or FC=0102h 7:0 Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5:1 N/A 0 Error - See 6.2.9

8.3.3 SCT Error Recovery Control command

The SCT Error Recovery Control command sets time limits for read and write error recovery . For commands that are not NCQ commands (see 4.16), these, these timers apply to command completion . For NCQ commands where in-order data delivery is enabled, these timers begin counting when the device begins to process the command, not when the command is sent to the device . These timers do not apply to streaming commands (see 4.26) or to queued commands (see 4.16) when out-of-order data delivery is enabled.

Table 204 defines the format of an SCT Error Recovery Control command written to the SCT Command/Status log (see A.1).

Table 204 — SCT Error Recovery Control command

Word	Name	Value	Description
0	Action Code	0003h	Set the read and write error recovery time
1	Function Code	0000h	Reserved
		0001h	Set New Value
		0002h	Return Current Value
		0003h-FFFFh	Reserved
2	Selection Code	0000h	Reserved
		0001h	Read Command Timer
		0002h	Write Command Timer
		0003h-FFFFh	Reserved
3	Recovery Time Limit		If the Function Code is 0001h, then this field contains the recovery time limit in 100 ms units (e.g., a value of 1 = 100 ms, 2 = 200 ms) . The tolerance is vendor specific.

If the Selection Code field is set to 0001h, then:

   a) the Recovery Time Limit field specifies the upper limit of the amount of time a device shall processes a read command in total;
   b) the device shall set the Read Command Timer to the value of the Recovery Time Limit fields; and
   c) if the Recovery Time Limit field is set to zero, then the device shall perform all available error recovery procedures (i.e., the Read Command Timer is disabled).

The device shall report command completion or stop processing the command and report an Uncorrectable Error (see 6.3.13) for the LBA that caused error recovery to be invoked prior to Read Command Timer expiration . Extended status code 0015h should be returned in the SCT Status data if the Read Command Timer expires . A failed logical sector may be recovered if the Recovery Time Limit is increased.

If the Selection Code field is set to 0002h, then:

   a) the Recovery Time Limit field specifies the upper limit of the amount of time a device shall processes a write command in total;
   b) the device shall set the Write Command Timer to the value of the Recovery Time Limit fields; and
   c) if the Recovery Time Limit field is set to zero, then the device shall perform all available error recovery procedures (i.e., the Write Command Timer is disabled).

A large Write Command Timer value allows the device to use more available error recovery procedures . If the Write Command Timer is about to expire, then the device should attempt to reallocate the data before the Write Command Timer expires . Extended status code 0015h should be returned in the SCT Status data if the Write Command Timer expires . If the device is unable to complete data reallocation before the Write Command Timer expires, then the device fails the command when the Write Command Timer expires . When write cache is enabled the operation of the Write Command Timer is vendor specific.

NOTE 26 — A host implementor should use the Write Command Timer with great caution as a very small timer value may cause a device to permanently reallocate good logical sectors as the result of temporary, external conditions (e.g., induced vibration).

The Extended status code shall be cleared when the next non-SCT command processed by the device, except when processing a read of the NCQ Command Error log (see A.12).

Read Command Timer and Write Command Timer values are set to default values at power-on but may be altered by an SCT command at any time . A device shall not change these settings while processing a hardware reset or a software reset.

Table 205 defines the format of the status response for a SCT Error Recovery Control command.

Table 205 — SCT Error Recovery Control command status response

Name	Description
Error	**Bit Description** 7:5 N/A 4 ID Not Found - See 6.3.6 . 3 N/A 2 Abort - See 6.3.2. 1 N/A 0 Obsolete
Count	If Function Code was 0002h, then this is the requested recovery limit (7:0); otherwise, this field is reserved.
LBA	**Bit Description** 27:8 Reserved 7:0 If the Function Code was 0002h, then this is the requested recovery limit (15:8); otherwise, this field is reserved.
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5:1 N/A 0 Error - See 6.2.9

8.3.4 SCT Feature Control command

The SCT Feature Control command reports and sets the state (i.e., enabled or disabled) of the features specified by the command.

Table 206 defines the format of a SCT Feature Control command written to the SCT Command/Status log (see A.1).

Table 206 — SCT Feature Control command

Word	Name	Value	Description
0	Action Code	0004h	Set or return the state of device features defined in table 207
1	Function Code	0000h	Reserved
		0001h	Set state for a feature
		0002h	Return the current state of a feature
		0003h	Return feature option flags
		0004h-FFFFh	Reserved
2	Feature Code		See table 207 for definition of the Feature Code
3	State		Feature Code dependent value
4	Option Flags		**Bit Description** 15:1 Reserved 0 If the function code is 0001h, then setting bit 0 to one shall cause the requested feature state change to be preserved during all power and reset events. If the function code is 0001h, then clearing bit 0 to zero shall cause the requested feature state change to be volatile (i.e., a hard reset causes the device to revert to the default value or to the last non-volatile setting).

Table 207 — Feature Code List

Feature Code	State Definition
0000h	Reserved
0001h	If State is set to 0001h, then the SET FEATURES command (see 7.50) shall determine the state of the write cache (see 7.50.4). If State is set to 0002h, then write cache shall be enabled. If State is set to 0003h, then write cache shall be disabled. If State is set to 0002h or 0003h, then write cache shall be set to the specified state, and any attempt to change the write cache settings using a SET FEATURES command shall not result in an error and shall not change the operational state of the write cache. In all cases, IDENTIFY DEVICE data word 85 bit 5 (see 7.18.7.41) shall reflect the current operational state of write cache (i.e., if set to one, then volatile write cache is enabled, and if cleared to zero, then write cache is disabled. The default is State set to 0001h.
0002h	If State is set to 0001h, then volatile Write Cache Reordering shall be enabled (i.e., disk write scheduling may be reordered by the device), regardless of the enabled or disabled state of the volatile write cache. If State is set to 0002h, then volatile Write Cache Reordering shall be disabled, and disk write scheduling is processed on a first-in-first-out (FIFO) basis, regardless of the enabled or disabled state of the volatile write cache. If volatile write cache is disabled, then the current volatile Write Cache Reordering state has no effect on writes. The state of volatile Write Cache Reordering has no effect on NCQ commands (see 4.16). The default is State set to 0001h.

0003h	The value in State sets the time interval for temperature logging.
	State set to 0000h is invalid.
	State may be set to 0001h to FFFFh to specify the temperature logging interval in minutes. This value applies to the Absolute HDA Temperature History (see table 211) . Issuing this command shall cause:
	    a) the queue to be reset and any prior values in the queues to be lost;
	    b) the Queue Index (see table 211) to be set to zero;
	    c) the first queue location to be set to the current value and all remaining queue locations set to 80h; and
	    d) the Sample Period value, Max Op Limit value, Over Limit value, Min Op Limit value, and Under Limit value to be preserved (see table 211).
	The default is State set to 0001h.

0004h-0005h	Reserved for Serial ATA
0006h-CFFFh	Reserved
D000h-FFFFh	Vendor Specific

Table 208 defines the format of the status response for a SCT Feature Control command.

Table 208 — SCT Feature Control command status response

Name	Description
Error	**Bit Description** 7:5 N/A 4 ID Not Found - See 6.3.6 . 3 N/A 2 Abort - See 6.3.2. 1 N/A 0 Obsolete
Count	If the Function Code was set to 0002h, then this is the Feature State (7:0). If the Function Code was set to 0003h, then this is the Option Flags (7:0). Otherwise this field is reserved.
LBA	**Bit Description** 27:8 Reserved 7:0 If the Function Code was set to 0002h, then this is the Feature State (15:8). If the Function Code was set to 0003h, then this is the Option Flags (15:8). Otherwise this field is reserved.
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5:1 N/A 0 Error - See 6.2.9

8.3.5 SCT Data Table command

The SCT Data Table command reads the specified data table.

Table 209 defines the format of an SCT Data Table command written to the SCT Command/Status log (see A.1).

Table 209 — SCT Data Table command

Word	Name	Value	Description
0	Action Code	0005h	Read a data table
1	Function Code	0000h	Reserved
		0001h	Read Table
		0002h-FFFFh	Reserved
2	Table ID	Word	See Table 210 for a list of SCT data tables

Table 210 — SCT Data Tables (by Table Identifier)

Table Id	Description
0000h	Invalid
0001h	Reserved
0002h	HDA Temperature History Table (in degrees Celsius) . See table 211 for more information.
0003h-0004h	Reserved for Serial ATA
0005h-CFFFh	Reserved
D000h-FFFFh	Vendor Specific

Table 211 — Absolute HDA Temperature (part 1 of 2)

Offset	Size	Field Name	Description
0..1	Word	Format Version	0002h - Data table format version
2..3	Word	Sampling Period	Absolute HDA Temperature sampling period in minutes . This is how often the device samples its temperature sensor . This period takes precedence over new read operations or write operations, but does not interrupt operations in process. The Sampling Period may be smaller than the timer interval between entries in the history queue. A value of 0000h in this field indicates that sampling is disabled.
4..5	Word	Interval	The timer interval between entries in the history queue . The default value of this field is vendor specific . This value should not be less than the Sampling Period.
6	Byte	Max Op Limit	Maximum recommended continuous operating temperature [c] . This is a two's complement number that allows a range from -127 °C to +127 °C to be indicated . 80h is an invalid value . This is a fixed value.
7	Byte	Over Limit	Maximum temperature limit . Operating the device above this temperature may cause physical damage to the device [c] . This is a two's complement number that allows a range from -127 °C to +127 °C to be indicated . 80h is an invalid value . This is a fixed value.
8	Byte	Min Op Limit	Minimum recommended continuous operating limit [c] . This is a two's complement number that allows a range from -127 °C to +127 °C to be indicated . 80h is an invalid value . This is a fixed value.
9	Byte	Under Limit	Minimum temperature limit . Operating the device below this temperature may cause physical damage to the device [c] . This is a two's complement number that allows a range from -127 °C to +127 °C to be indicated . 80h is an invalid value . This is a fixed value.
10..29	Byte [20]	reserved	
30..31	Word	CB Size	Number of entry locations in history buffer . This number shall be in the range of 128..478.
32..33	Word	CB Index	Last updated entry in buffer . CB Index is zero-based, so CB Index 0000h is the first location in the buffer (i.e., at offset 34) . The most recent temperature entered in the buffer is at CB Index + 34 [a] [b].

Table 211 — Absolute HDA Temperature (part 2 of 2)

Offset	Size	Field Name	Description
34..(CB Size + 33)	Byte [CB Size]	CB	This is a circular buffer of absolute HDA Temperature values . Other device activities (e.g., data transfer), take priority over writing this data to non-volatile storage . These are two's complement numbers that allow a range from -127 °C to +127 °C to be indicated . A value of 80h indicates an initial value or a discontinuity in temperature recording. The time between samples may vary because commands shall not be interrupted . The sampling period is the minimum time between samples [a]. If the host changes the logging interval using the volatile option, then the interval between entries in the queue may change between power cycles with no indication to the host.
(CB Size + 34)..511	Byte [512 - CB Size - 34]	reserved	Shall be zero.

[a] The Absolute HDA Temperature History is preserved during the processing of all power events and reset events with the requirement that when the device powers up, a new entry is made in the history queue with a value of 80h (i.e., an invalid absolute temperature value) to indicate the discontinuity in temperature resulting from the device being turned off . If the device does not sample temperatures during a certain power state (e.g., Sleep or Standby) (see 4.19.4), then a value of 80h is entered into the history queue to indicate that temperature sensing has resumed.

[b] When the Absolute HDA Temperature history is cleared (e.g., for new devices or after changing the Logging Interval) the Queue Index shall be set to zero and the first queue location shall be set to the current Absolute HDA Temperature value . All remaining queue locations shall be set to 80h.

[c] These values should take into account the accuracy of the temperature sensor . The placement, accuracy, and granularity of temperature sensors to support table 211 are vendor specific.

Table 212 defines the format of the status response for an SCT Data Table command.

Table 212 — SCT Data Table command status response

Name	Description
Error	**Bit Description** 7:5 N/A 4 ID Not Found - See 6.3.6 . 3 N/A 2 Abort - See 6.3.2. 1 N/A 0 Obsolete
Count	Reserved
LBA	**Bit Description** 27:24 Reserved 23:8 For Table ID 0002h, 0001h (i.e., Number of data blocks requested); otherwise reserved. 7:0 Reserved.
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5:1 N/A 0 Error - See 6.2.9

9 Normal and Error Outputs

9.1 Overview

The commands listed in clause 7 each have subclauses labeled Normal Outputs and Error Outputs . Subclauses 9.2 and 9.3 document the return data format for all the commands described in clause 7 . Each command in clause 7 may provide additional information about a normal or error output, however, all the information specified in clause 9 shall also apply to the command.

The references preceding each table indicate each command that generates the output in the table.

9.2 Normal Outputs

The tables in this subclause specify the Normal Outputs a command returns.

Table 213 specifies the normal outputs for the commands defined in 7.2.

Table 213 — Error Bit Defined For Normal Output

Name	Description
Error	N/A
Count	N/A
LBA	N/A

Device	**Bit Description**
	
	  7 Obsolete
	
	  6 N/A
	
	  5 Obsolete
	
	  4 Transport Dependent - See 6.2.12
	
	3:0 Reserved

Status	**Bit Description**
	
	7:6 Transport Dependent - See 6.2.12.
	
	  5 Device Fault – See 6.2.7
	
	  4 N/A
	
	  3 Transport Dependent - See 6.2.12.
	
	  2 N/A
	
	  1 Sense Data Available - See 6.2.10
	
	  0 Error - See 6.2.9

Table 214 specifies the normal outputs for the commands defined in 7.3.

Table 214 — Extended Error Code for Normal Output

Name	Description
Error	Extended error code (see table 26)
Count	Vendor Specific
LBA	Vendor Specific
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5:2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 215 specifies the normal outputs for the commands defined in 7.11.5, 7.11.2, 7.11.3, 7.11.6, 7.13, 7.16, 7.18, 7.19, 7.20, 7.22, 7.23.4, 7.22.11, 7.25, 7.27, 7.32, 7.36, 7.40, 7.44, 7.45, 7.46, 7.47, 7.48, 7.49, 7.50, 7.50.19.2.3, 7.50.19.3.3, 7.50.19.4.5, 7.50.19.5.3, 7.51.5, 7.51.4, 7.51.7, 7.51.3, 7.53, 7.54, 7.55.2, 7.55.3, 7.55.4, 7.55.6, 7.55.7, 7.55.9, 7.56, 7.57, 7.63, 7.65, 7.71, 7.74, and 7.78.

Table 215 — Generic Normal Output (No LBA Return Value) for Normal Output

Name	Description
Error	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A or Alignment Error - See 6.2.2 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 216 specifies the normal outputs for the commands defined in 7.13 and 7.14.

Table 216 — Download Microcode Normal Output

Name	Description
Error	N/A
Count	If Download with offsets and save microcode for immediate and future use was specified (see 7.13), then this field contains a value as specified in table 47 . Otherwise, this field is N/A.
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A or Alignment Error - See 6.2.2 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 217 specifies the normal outputs for the commands defined in 7.4, 7.5, and 7.6.

Table 217 — CFA Normal Output

Name	Description
Error	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12 5:2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 218 specifies the normal outputs for the commands defined in 7.7.

Table 218 — Media Card Type Normal Output

Name	Description
Error	N/A
Count	55h

LBA	**Bit** **Description**
	
	27 Write Protect - shall be set to one if the device is write protected, Write Protect shall be cleared to zero if the device is not write protected.
	
	26:24 Media Type
	
	     Value **Description**
	     000b Reserved
	     001b SD Memory Card
	     010b Obsolete
	     011b Obsolete
	     100b Obsolete
	     101b-111b Reserved
	
	23:8 Card specific Data
	
	7:0 Shall be set to AAh

Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit** **Description** 7:6 Transport Dependent - See 6.2.12 5 Device Fault - See 6.2.7 4:2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 219 specifies the normal outputs for the commands defined in 7.8.

Table 219 — Check Power Mode Normal Output (part 1 of 2)

Name	Description
Error	N/A

Count	**Value Description**
	
	00h Device is in the:
	    a) PM2:Standby state and Extended Power Conditions feature set is not supported; or
	    b) PM2:Standby state, the Extended Power Conditions feature set is supported, and the device is in the Standby_z power condition.
	
	01h Device is in the PM2:Standby state, the Extended Power Conditions feature set is supported, and the device is in the Standby_y power condition.
	
	02h..3Fh Reserved
	
	40h Device is:
	    a) in the PM0:Active state;
	    b) the NV Cache power mode is enabled; and
	    c) the spindle is spun down or spinning down.
	
	41h Device is:
	    a) in the PM0:Active state;
	    b) the NV Cache power mode is enabled; and
	    c) the spindle is spun up or spinning up.
	
	42h..7Fh Reserved
	
	80h Device is in the
	    a) PM1:Idle state and Extended Power Conditions feature set is not supported; or
	    b) PM1:Idle state, Extended Power Conditions feature set is supported, and APM is enabled.
	
	81h Device is in the PM1:Idle State, Extended Power Conditions feature set is supported, and the device is in the Idle_a power condition.
	
	82h Device is in the PM1:Idle State, Extended Power Conditions feature set is supported, and the device is in the Idle_b power condition.
	
	83h Device is in the PM1:Idle State, Extended Power Conditions feature set is supported, and the device is in the Idle_c power condition.
	
	84h..FEh Reserved
	
	FFh Device is in the PM0:Active state or PM1:Idle State.

LBA	N/A

Table 219 — Check Power Mode Normal Output (part 2 of 2)

Name	Description
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 220 specifies the normal outputs for the commands defined in 7.9, 7.38, and 7.76.

Table 220 — Stream Normal Output

Name	Description
Error	N/A
Count	Reserved
LBA	Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12 5 Stream Error - See 6.2.11 4 N/A 3 Transport Dependent - See 6.2.12 2 N/A or Alignment Error - See 6.2.2 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 221 specifies the normal outputs for the commands defined in 3.1.79, 7.12, 7.15, 7.18, and 7.36.

Table 221 — Device Signatures for Normal Output

Name	Description					
Error	Diagnostic Results - The diagnostic code as described in table 50 is returned. This field shall be reserved for the DEVICE RESET command (see 7.12) . For the READ SECTOR(S) command (see 7.36) or the IDENTIFY DEVICE command (see 7.18), bit 2 of this field shall be set to one and the remaining bits are N/A.					
Count		**Bit**	**ATA Device** [a]	**ATAPI Device** [a]	**Reserved for SATA** [a]	**Reserved for SATA** [a]	**Obsolete** [a]
		Count (7:0)	01h	01h	01h	01h	N/A
LBA		LBA (27:24)	Reserved	Reserved	Reserved	Reserved	Reserved
		LBA (23:16)	00h	EBh	C3h	96h	AAh
		LBA (15:8)	00h	14h	3Ch	69h	CEh
		LBA (7:0)	01h	01h	01h	01h	N/A

Device	**Bit Description**
	  7 Obsolete
	  6 N/A
	  5 Obsolete
	  4 Transport Dependent - See 6.2.12
	3:0 Reserved					

Status	**Bit Description**
	7:6 Transport Dependent - See 6.2.12
	  5 Device Fault - See 6.2.7
	  4 N/A
	  3 Transport Dependent - See 6.2.12
	  2 N/A
	  1 Sense Data Available - See 6.2.10
	  0 Shall be cleared to zero					

[a] All other values are reserved						

Table 222 specifies the normal outputs for the commands defined in 7.21.

Table 222 — IDLE Unload Normal Output

Name	Description
Error	N/A
Count	N/A
LBA	**Bit Description** 27:8 N/A 7:0 C4h
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 223 specifies the normal outputs for the commands defined in 7.24.6.

Table 223 — ATAPI Normal Output

Name	Description
Error	N/A
Interrupt Reason	**Bit Description** 7:2 Obsolete 1 Input/Output - See 6.4.3 0 Command/Data - See 6.4.2
LBA	**Bit Description** 27:24 N/A 23:8 Byte Count 7:0 N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7 Transport Dependent - See 6.2.12 6 N/A 5:4 Obsolete 3 Transport Dependent - See 6.2.12 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9 . Shall be cleared to zero

Table 224 specifies the normal outputs for the commands defined in 7.34 and 7.51.2.

Table 224 — HPA Normal Output

Name	Description
Error	N/A
Count	N/A
LBA	Maximum LBA
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12 5:2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 225 specifies the normal outputs for the commands defined in 7.55.5.

Table 225 — SMART Off-Line Immediate Normal Output

Name	Description
Error	N/A
Count	N/A

LBA	**Bit Description**
	
	27:24 N/A
	
	23:8
	
	        Value Description
	    C24Fh The subcommand specified a captive self-test that has completed without error.
	    All Other The subcommand specified an off-line routine including an off-line Values self-test routine.
	
	7:0 N/A

Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 226 specifies the normal outputs for the commands defined in 7.55.8.

Table 226 — SMART Return Status Normal Output

Name	Description
Error	N/A
Count	N/A

LBA	**Bit Description**
	27:24 N/A
	23:8
	
	     Value Description
	     C24Fh The subcommand specified a captive self-test that has completed without error.
	     2CF4h The device has detected a threshold exceeded condition
	     All Other Undefined
	     Values
	7:0 N/A

Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 227 specifies the normal outputs for the commands defined in 7.10, 7.17, 7.22.5, 7.28, 7.30, 7.33, 7.37, 7.41, 7.59, 7.61, 7.66, 7.67, 7.69, 7.72, 7.73, and 7.75.

Table 227 — Generic Extended Normal Output

Name	Description
Error	Reserved
Count	Reserved
LBA	Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12 2 N/A or Alignment Error - See 6.2.2 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 228 specifies the normal outputs for the commands defined in 7.35 and 7.52.

Table 228 — SETMAX Extended Normal Output

Name	Description
Error	Reserved
Count	Reserved
LBA	Maximum LBA
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12 5:2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 229 specifies the normal outputs for the commands defined in 7.22.3, 7.22.7, 7.22.8, and 7.22.9.

Table 229 — NV Cache Normal Output

Name	Description
Error	Reserved
Count	Reserved
LBA	Number of unpinned logical blocks remaining
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 230 specifies the normal outputs for the commands defined in 7.22.4.

Table 230 — NV Cache Flush Normal Output

Name	Description
Error	Reserved
Count	Reserved
LBA	Number of unflushed logical blocks remaining
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 231 specifies the normal outputs for the commands defined in 7.29.4 and 7.68.4.

Table 231 — NCQ Command Acceptance Normal Output

Name	Description
Error	Shall be cleared to zero
Count	N/A
LBA	N/A
Device	**Bit Description** 7:4 N/A 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 232 specifies the normal outputs for the commands defined in 7.29.5 and 7.68.5.

Table 232 — NCQ Normal Outputs

Name	Description
SATA Status	Transport Dependent
Error	Shall be cleared to zero
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A or Alignment Error - See 6.2.2 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9
SActive	**Bit Description** 31:0 Transport dependent completion indicator

Table 233 specifies the normal outputs for the commands defined in 7.42.

Table 233 — REQUEST SENSE DATA EXT Normal Output

Name	Description
Error	Reserved
Count	Reserved
LBA	**Bit Description** 47:24 Vendor Specific 23:20 Reserved 19:16 Sense Key (see 7.42.4) 15:8 Additional Sense Code (see 7.42.4) 7:0 Additional Sense Code Qualifier (see 7.42.4)
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5:2 Reserved 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 234 specifies the normal outputs for the commands defined in 7.43.

Table 234 — Sanitize Device Normal Output

Name	Description
Error	Reserved
Count	**Bit Description** 15 Sanitize operation complete without error 14 Sanitize operation in progress 13:0 Reserved
LBA	**Bit Description** 47:16 Reserved 15:0 Sanitize Progress Indication - Percent complete indication of the total operation in progress . This value shall be FFFFh if a sanitize operation is not in process . The returned value is a numerator that has 65 536 (1_0000h) as its denominator.
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

9.3 Error Outputs

The tables in this subclause specify the Error Outputs a command returns . References to these tables are found in clause 7.

If the Sense Data Reporting feature set is enabled and there is sense data available, then the Error field shall be set to 7Fh and the Error bit in the Status field shall be set to one . If the Sense Data Reporting feature set has been enabled with the Sense Data Available status bit reporting set to one (see 7.50.17), then the device notifies the host of additional information by setting the Sense Data Available bit in the Status field to one.

Table 235 specifies the error outputs for the commands defined in 7.1.9.

Table 235 — Unsupported Command Error

Name	Description
Error	**Bit Description** 7:3 N/A 2 Abort - See 6.3.2 1:0 N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7:4 N/A 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5:2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 236 specifies the error outputs for the commands defined in 7.2.

Table 236 — CFA Erase Error

Name	Description
Error	**Bit Description** 7:5 N/A 4 ID Not Found - See 6.3.6 3 N/A 2 Abort - See 6.3.2 1 N/A 0 Media Error - See 6.3.11
Count	N/A
LBA	LBA of first unrecoverable error
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4:2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 237 specifies the error outputs for the commands defined in 7.5 and 7.6.

Table 237 — CFA Write Error

Name	Description
Error	**Bit Description** 7:5 N/A 4 ID Not Found - See 6.3.6 3 N/A 2 Abort - See 6.3.2 1 N/A 0 Media Error - See 6.3.11
Count	N/A
LBA	LBA of first unrecoverable error
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 Transport Dependent - See 6.2.12 3:2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 238 specifies the error outputs for the commands defined in 7.3, 7.4, and 7.8.

Table 238 — CFA & Check Power Mode Abort Error

Name	Description
Error	**Bit Description** 7:3 N/A 2 Abort - See 6.3.2 1:0 N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4:2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 239 specifies the error outputs for the commands defined in 7.7, 7.11.5, 7.11.2, 7.20, 7.21, 7.42, 7.45, 7.47, 7.50.22, 7.50.19.2.4, 7.50.19.3.4, 7.50.19.4.6, 7.50.19.5.4, 7.53, 7.54, 7.55.2, 7.55.3, 7.55.4, 7.55.8, 7.56, 7.57, and 7.78.

Table 239 — Generic Abort wo/ICRC Error

Name	Description
Error	**Bit Description** 7:3 N/A 2 Abort - See 6.3.2 1:0 N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 240 specifies the error outputs for the commands defined in 7.11.3, 7.13, 7.18.6, 7.19, 7.25, 7.44, 7.46, 7.48, 7.49, and 7.63.

Table 240 — Generic Abort Error

Name	Description
Error	**Bit Description** 7 Interface CRC - See 6.3.10 6:3 N/A 2 Abort - See 6.3.2 1:0 N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 241 specifies the error outputs for the commands defined in 7.59 and 7.61.

Table 241 — Trusted Abort Error

Name	Description

Error	**Bit Description**
	
	  7 Interface CRC - See 6.3.10
	
	6:3 N/A
	
	  2 Abort - See 6.3.2
	
	1:0 N/A

Count	Reserved
LBA	Reserved

Device	**Bit Description**
	
	  7 Obsolete
	
	  6 N/A
	
	  5 Obsolete
	
	  4 Transport Dependent - See 6.2.12
	
	3:0 Reserved

Status	**Bit Description**
	
	7:6 Transport Dependent - See 6.2.12.
	
	  5 Device Fault - See 6.2.7
	
	  4 N/A
	
	  3 Transport Dependent - See 6.2.12
	
	  2 N/A
	
	  1 Sense Data Available - See 6.2.10
	
	  0 Error - See 6.2.9

Table 242 specifies the error outputs for the commands defined in 7.34, 7.51.4, and 7.51.3.

Table 242 — Generic SET MAX Error

Name	Description
Error	**Bit Description** 7:3 N/A 2 Abort - See 6.3.2 1:0 N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5:2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 243 specifies the error outputs for the commands defined in 7.51.7.

Table 243 — SET MAX Unlock Error

Name	Description

Error	**Bit Description**
	
	  7 Interface CRC - See 6.3.10
	6:3 N/A
	  2 Abort - See 6.3.2
	1:0 N/A

Count	N/A
LBA	N/A

Device	**Bit Description**
	
	  7 Obsolete
	  6 N/A
	  5 Obsolete
	  4 Transport Dependent - See 6.2.12
	3:0 Reserved

Status	**Bit Description**
	
	7:6 Transport Dependent - See 6.2.12.
	  5 N/A
	  1 Sense Data Available - See 6.2.10
	  0 Error - See 6.2.9

Table 244 specifies the error outputs for the commands defined in 7.9.

Table 244 — Configure Stream Error

Name	Description
Error	**Bit Description** 7:3 N/A 2 Abort - See 6.3.2 1:0 N/A
Count	Reserved
LBA	Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Stream Error - See 6.2.11 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 245 specifies the error outputs for the commands defined in 7.16.

Table 245 — Flush Cache Error

Name	Description
Error	**Bit Description** 7:3 N/A 2 Abort - See 6.3.2 1:0 N/A
Count	N/A
LBA	LBA of first unrecoverable error
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 246 specifies the error outputs for the commands defined in 7.17.

Table 246 — Flush Cache Ext Error

Name	Description
Error	**Bit Description** 7:3 N/A 2 Abort - See 6.3.2 1:0 N/A
Count	Reserved
LBA	LBA of first unrecoverable error
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 247 specifies the error outputs for the commands defined in 7.28.

Table 247 — Read DMA Ext Error

Name	Description
Error	**Bit Description** 7 Interface CRC - See 6.3.10 6 Uncorrectable Error - See 6.3.13. 5 Obsolete 4 ID Not Found - See 6.3.6 3 Obsolete 2 Abort - See 6.3.2 1:0 Obsolete
Count	Reserved
LBA	LBA of first unrecoverable error
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 248 specifies the error outputs for the commands defined in 7.30.

Table 248 — Read Log Ext Error

Name	Description
Error	**Bit Description** 7 Interface CRC - See 6.3.10 6 Uncorrectable Error - See 6.3.13. 5 N/A 4 ID Not Found - See 6.3.6 3 N/A 2 Abort - See 6.3.2 . 1 N/A 0 Obsolete
Count	Reserved
LBA	Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 249 specifies the error outputs for the commands defined in 7.27, 7.32, 7.36, and 7.40.

Table 249 — Read PIO Error

Name	Description
Error	**Bit Description** 7 Interface CRC - See 6.3.10 6 Uncorrectable Error - See 6.3.13 5 Obsolete 4 ID Not Found - See 6.3.6 3 Obsolete 2 Abort - See 6.3.2 1:0 Obsolete
Count	N/A
LBA	LBA of first unrecoverable error
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 250 specifies the error outputs for the commands defined in 7.38.

Table 250 — Read Stream Error

Name	Description
Error	**Bit** **Description** 7 Interface CRC - See 6.3.10 6 Uncorrectable Error - See 6.3.13. 5 Obsolete 4 ID Not Found - See 6.3.6 3 Obsolete 2 Abort - See 6.3.2 1 Obsolete 0 Command Completion Time Out - See 6.3.4
Count	Length of Stream Error - number of contiguous logical sectors containing potentially bad data, beginning with the LBA of the first logical sector with an uncorrectable error
LBA	LBA of first unrecoverable error
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit** **Description** 7:6 Transport Dependent - See 6.2.12. 5 Stream Error - See 6.2.11. 4 Deferred Write Error - See 6.2.6. 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 251 specifies the error outputs for the commands defined in 7.51.2 and 7.51.5.

Table 251 — HPA Error

Name	Description
Error	**Bit Description** 7:5 N/A 4 ID Not Found - See 6.3.6 . 3 N/A 2 Abort - See 6.3.2. 1 N/A 0 Obsolete
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 252 specifies the error outputs for the commands defined in 7.55.9.

Table 252 — Write Log Error

Name	Description

Error	**Bit Description**
	  7 Interface CRC - See 6.3.10
	6:5 N/A
	  4 ID Not Found - See 6.3.6 .
	  3 N/A
	  2 Abort - See 6.3.2.
	  1 N/A
	  0 Obsolete

Count	N/A
LBA	N/A

Device	**Bit Description**
	  7 Obsolete
	  6 N/A
	  5 Obsolete
	  4 Transport Dependent - See 6.2.12
	3:0 Reserved

Status	**Bit Description**
	7:6 Transport Dependent - See 6.2.12
	  5 Device Fault - See 6.2.7
	  4 N/A
	  3 Transport Dependent - See 6.2.12
	  2 N/A
	  1 Sense Data Available - See 6.2.10
	  0 Error - See 6.2.9

Table 253 specifies the error outputs for the commands defined in 7.10 and 7.69.

Table 253 — Write Log Ext Error or Data Set Management Error

Name	Description
Error	**Bit Description** 7 Interface CRC - See 6.3.10 6:5 N/A 4 ID Not Found - See 6.3.6 . 3 N/A 2 Abort - See 6.3.2. 1 N/A 0 Obsolete
Count	Reserved
LBA	Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 254 specifies the error outputs for the commands defined in 7.55.5.

Table 254 — SMART Error

Name	Description
Error	**Bit** **Description** 7:5 N/A 4 ID Not Found - See 6.3.6 . 3 N/A 2 Abort - See 6.3.2. 1 N/A 0 Obsolete
Count	Reserved

LBA	**Bit** **Description**
	
	27:24 N/A
	
	23:8
	
	      Value **Description**
	
	      C24Fh Subcommand specified a captive self-test and some error other than a self-test routine failure occurred (i.e., if the sub-command is not supported or field values are invalid)
	
	      2CF4h the subcommand specified a captive self-test routine that has failed during processing.
	
	      All Other Values the subcommand specified an off-line routine including an off-line self-test routine.
	
	7:0 N/A

Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit** **Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 255 specifies the error outputs for the commands defined in 7.66, 7.67, 7.72, 7.73 and 7.75.

Table 255 — Write Extended Error

Name	Description

Error	**Bit Description**
	
	  7 Interface CRC - See 6.3.10
	
	6:5 Obsolete.
	
	  4 ID Not Found - See 6.3.6
	
	  3 Obsolete
	
	  2 Abort - See 6.3.2
	
	  1 Obsolete
	
	  0 N/A

Count	Reserved
LBA	LBA of first unrecoverable error

Device	**Bit Description**
	
	  7 Obsolete
	
	  6 N/A
	
	  5 Obsolete
	
	  4 Transport Dependent - See 6.2.12
	
	3:0 Reserved

Status	**Bit Description**
	
	7:6 Transport Dependent - See 6.2.12
	
	  5 Device Fault - See 6.2.7
	
	  4 N/A
	
	  3 Transport Dependent - See 6.2.12
	
	  2 N/A
	
	  1 Sense Data Available - See 6.2.10
	
	  0 Error - See 6.2.9

Table 256 specifies the error outputs for the commands defined in 7.76.

Table 256 — Write Stream Error

Name	Description

Error	**Bit Description**
	  7 Interface CRC - See 6.3.10
	6:5 Obsolete
	  4 ID Not Found - See 6.3.6
	  3 Obsolete
	  2 Abort - See 6.3.2
	  1 Obsolete
	  0 Command Completion Time Out - See 6.3.4

Count	Length of Stream Error - number of contiguous logical sectors containing potentially bad data, beginning with the LBA of the first logical sector with an uncorrectable error
LBA	LBA of first unrecoverable error

Device	**Bit Description**
	  7 Obsolete
	  6 N/A
	  5 Obsolete
	  4 Transport Dependent - See 6.2.12
	3:0 Reserved

Status	**Bit Description**
	7:6 Transport Dependent - See 6.2.12.
	  5 Stream Error - See 6.2.11.
	  4 Deferred Write Error - See 6.2.6.
	  3 Transport Dependent - See 6.2.12.
	  2 N/A
	  1 Sense Data Available - See 6.2.10
	  0 Error - See 6.2.9 .

Table 257 specifies the error outputs for the commands defined in 7.11.6.

Table 257 — DCO Set Error (part 1 of 2)

Name	Description
Error	**Bit Description** 7 Interface CRC - See 6.3.10 6:3 N/A 2 Abort - See 6.3.2 1:0 N/A
Count	Vendor Specific
LBA	**Bit Description** 27:24 N/A 23:16 Word Location - If the command was aborted because an attempt was made to modify a bit that shall not be modified with the device in its current state, then this field shall contain the offset of the first word encountered that the device shall not change . If an illegal maximum LBA is encountered, then this field shall be set to 03h . If a checksum error occurred, then this field shall be set to FFh . A value of 00h indicates that the Data Structure Revision was invalid. 15:0 Bit Location - If the command was aborted because an attempt was made to disable at least one mode or feature that shall not be disabled with the device in its current state, then this field shall contain an array of bits that correspond to the device configuration overlay data structure listed in Table 11 relative to the word indicated in bits (23:16) (i.e., Word Location) . A one in this array indicates that the requested mode or feature shall not be disabled by the device . If the bit location is not reported, then the value shall be 0000h.
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved

Table 257 — DCO Set Error (part 2 of 2)

Name	Description
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 258 specifies the error outputs for the commands defined in 7.23.

Table 258 — NOP Error

Name	Description
Error	**Bit Description** 7:3 N/A 2 Abort - See 6.3.2 1:0 N/A
Count	Initial Value
LBA	Initial Value

Device	**Bit Description**
	  7 Obsolete
	  6 N/A
	  5 Obsolete
	  4 Transport Dependent - See 6.2.12
	3:0 Reserved

Status	**Bit Description**
	7:6 Transport Dependent - See 6.2.12.
	  5 Device Fault - See 6.2.7
	  4 N/A
	  3 Transport Dependent - See 6.2.12.
	  2 N/A
	  1 Sense Data Available - See 6.2.10
	  0 Error - See 6.2.9

Table 259 specifies the error outputs for the commands defined in 7.24.

Table 259 — PACKET command Error

Name	Description

Error	**Bit Description**
	7:4 Sense Key - See 6.3.12
	  3 N/A
	  2 Abort - See 6.3.2
	  1 End of Media - See 6.3.5
	  0 Illegal Length Indicator - See 6.3.7

Interrupt Reason	**Bit Description**
	7:2 Obsolete
	  1 Input/Output - See 6.4.3 . Shall be set to one
	  0 Command/Data - See 6.4.2 . Shall be set to one

LBA	N/A

Device	**Bit Description**
	  7 Obsolete
	  6 N/A
	  5 Obsolete
	  4 Transport Dependent - See 6.2.12
	3:0 Reserved

Status	**Bit Description**
	7:6 Transport Dependent - See 6.2.12.
	  5 N/A
	  4 Obsolete.
	  3 Transport Dependent - See 6.2.12.
	  2 N/A
	  1 Sense Data Available - See 6.2.10
	  0 Check Condition - See 6.2.4.

Table 260 specifies the error outputs for the commands defined in 7.55.6 and 7.55.7.

Table 260 — SMART Read Log/SMART Read Data Error

Name	Description
Error	**Bit Description** 7 Interface CRC - See 6.3.10 6 Uncorrectable Error - See 6.3.13. 5 N/A 4 ID Not Found - See 6.3.6 3 N/A 2 Abort - See 6.3.2 . 1 N/A 0 Obsolete
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 261 specifies the error outputs for the commands defined in 7.33, 7.37 and 7.41.

Table 261 — Read PIO Extended Error

Name	Description
Error	**Bit** **Description** 7 Interface CRC - See 6.3.10 6 Uncorrectable Error - See 6.3.13. 5 N/A 4 ID Not Found - See 6.3.6 3 N/A 2 Abort - See 6.3.2 . 1 N/A 0 Obsolete
Count	Reserved
LBA	LBA of first unrecoverable error
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit** **Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 262 specifies the error outputs for the commands defined in 7.35.

Table 262 — Read Native Max Extended Error

Name	Description
Error	**Bit Description** 7:3 N/A 2 Abort - See 6.3.2 . 1 N/A 0 Obsolete
Count	Reserved
LBA	Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5:2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 263 specifies the error outputs for the commands defined in 7.52.

Table 263 — SETMAX Extended Error

Name	Description
Error	**Bit Description** 7:5 N/A 4 ID Not Found - See 6.3.6 . 3 N/A 2 Abort - See 6.3.2. 1 N/A 0 Obsolete
Count	Reserved
LBA	Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 264 specifies the error outputs for the commands defined in 7.71 and 7.74.

Table 264 — Write Error

Name	Description
Error	**Bit Description** 7 Interface CRC - See 6.3.10 6:5 Obsolete 4 ID Not Found - See 6.3.6 3 Obsolete 2 Abort - See 6.3.2. 1 Obsolete 0 N/A
Count	N/A
LBA	LBA of first unrecoverable error
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 265 specifies the error outputs for the commands defined in 7.65.

Table 265 — Write DMA Error

Name	Description
Error	**Bit Description** 7 Interface CRC - See 6.3.10 6:5 Obsolete 4 ID Not Found - See 6.3.6 3 Obsolete 2 Abort - See 6.3.2. 1:0 Obsolete
Count	N/A
LBA	LBA of first unrecoverable error
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 266 specifies the error outputs for the commands defined in 7.22.3.

Table 266 — NV Cache Add Abort Error

Name	Description
Error	**Bit Description** 7 Interface CRC - See 6.3.10 6:3 Reserved 2 Abort - See 6.3.2 1 Insufficient LBA Range Entries - See 6.3.8 0 Insufficient NV Cache space - See 6.3.9
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 267 specifies the error outputs for the commands defined in 7.22.9.

Table 267 — NV Cache Remove Abort Error

Name	Description

Error	**Bit Description**
	  7 Interface CRC - See 6.3.10
	6:3 Reserved
	  2 Abort - See 6.3.2
	  1 Reserved
	  0 Attempted partial range removal from the NV Cache pinned set - See 6.3.3

Count	N/A
LBA	N/A

Device	**Bit Description**
	  7 Obsolete
	  6 N/A
	  5 Obsolete
	  4 Transport Dependent - See 6.2.12
	3:0 Reserved

Status	**Bit Description**
	7:6 Transport Dependent - See 6.2.12.
	  5 Device Fault - See 6.2.7
	  4 N/A
	  3 Transport Dependent - See 6.2.12.
	  2 N/A
	  1 Sense Data Available - See 6.2.10
	  0 Error - See 6.2.9

Table 268 specifies the error outputs for the commands defined in 7.22.4 and 7.22.5.

Table 268 — NV Cache Abort Error

Name	Description
Error	**Bit Description** 7 Reserved 6:3 Reserved 2 Abort - See 6.3.2 1:0 Reserved
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 269 specifies the error outputs for the commands defined in 7.22.8 and 7.22.7.

Table 269 — NV Cache Abort with Data Transfer Error

Name	Description

Error	**Bit Description**
	
	   7 Interface CRC - See 6.3.10
	
	6:3 Reserved
	
	   2 Abort - See 6.3.2
	
	1:0 Reserved

Count	N/A
LBA	N/A

Device	**Bit Description**
	
	   7 Obsolete
	
	   6 N/A
	
	   5 Obsolete
	
	   4 Transport Dependent - See 6.2.12
	
	3:0 Reserved

Status	**Bit Description**
	
	7:6 Transport Dependent - See 6.2.12.
	
	   5 Device Fault - See 6.2.7
	
	   4 N/A
	
	   3 Transport Dependent - See 6.2.12.
	
	   2 N/A
	
	   1 Sense Data Available - See 6.2.10
	
	   0 Error - See 6.2.9

Table 270 specifies the error outputs for the commands defined in 7.29.6 and 7.68.6.

Table 270 — NCQ Command Acceptance Error

Name	Description

Error	**Bit Description**
	
	  7 Interface CRC - See 6.3.10.
	
	6:3 N/A
	
	  2 Abort - See 6.3.2.
	
	1:0 N/A

Count	N/A
LBA	N/A
Device	**Bit Description** 7:4 N/A 3:0 Reserved

Status	**Bit Description**
	
	7:6 Transport Dependent - See 6.2.12.
	
	  5 Device Fault – See 6.2.7
	
	  4 N/A
	
	  3 Transport Dependent - See 6.2.12.
	
	  2 N/A
	
	  1 Sense Data Available - See 6.2.10
	
	  0 Error - See 6.2.9

Table 271 specifies the error outputs for the commands defined in 7.68.6.

Table 271 — NCQ Write Command Aborted Error

Name	Description
SATA Status	Transport Dependent
Error	**Bit Description** 7 Interface CRC - See 6.3.10 6:5 Obsolete 4 ID Not Found - See 6.3.6 3 Obsolete 2 Abort - See 6.3.2 1:0 Obsolete
Status	**Bit Description** 7 Shall be cleared to zero 6 Transport Dependent - See 6.2.12 5 Device Fault – See 6.2.7 4 N/A 3 Shall be cleared to zero. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9
SActive	**Bit Description** 31:0 Transport dependent completion indicator

Table 272 specifies the error outputs for the commands defined in 7.29.6.

Table 272 — NCQ Read Command Aborted Error

Name	Description
SATA Status	Transport Dependent
Error	**Bit Description** 7 Interface CRC - See 6.3.10 6 Uncorrectable Error - See 6.3.13 5 Obsolete 4 ID Not Found - See 6.3.6 3 Obsolete 2 Abort - See 6.3.2 1:0 Obsolete
Status	**Bit Description** 7 Shall be cleared to zero 6 Transport Dependent - See 6.2.12 5 Device Fault – See 6.2.7 4 N/A 3 Shall be cleared to zero. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9
SActive	**Bit Description** 31:0 Transport dependent completion indicator

Table 273 specifies the error outputs for the commands defined in 7.43.

Table 273 — Sanitize Device Error

Name	Description
Error	Error **Bit** **Description** 7:3 Reserved 2 Abort - See 6.3.2. 1:0 Reserved
Count	N/A

LBA	**Bit** **Description**
	47:8 N/A
	7:0
	
	    Value **Description**
	    00h Reserved
	    01h Sanitize Command Unsuccessful . A BLOCK ERASE EXT command (see 7.43.2), CRYPTO SCRAMBLE EXT command (see 7.43.3), or OVERWRITE EXT command(see 7.43.4) completed with physical sectors that are available to be allocated for user data that were not successfully sanitized (e.g., Cryptographically scrambled, Block Erased, or Overwritten (see 4.21)).
	    02h Unsupported Sanitize Device command received – A command for an unsupported sanitize method was received.
	    03h..FFh Reserved

Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit** **Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Annex A
(Normative)

Log Definitions

A.1 Overview

This Annex provides a description of all logs . All logs are optional unless otherwise specified . These logs are accessible via commands (see 7.30, 7.31, 7.55.7, 7.55.9, 7.69, 7.70) . Table A.2 is a summary of these logs . The following terms are associated with logs:

a) name: the log name is a term that describes the data in the associated log;
b) address: each log name has an associated numeric value that is the log address; and
c) page: each log is composed or one or more pages.

The log address is used by read log commands and write log commands to access a specific log . Table A.1 shows an example layout of logs . Data transfer associated with the SMART READ LOG command and the SMART WRITE LOG command starts from the first page . GPL feature set (see 4.11) commands allow the host to specify the starting log page number.

Table A.1 — Example Log Structure

Log Name	Log Address	Log pages
Log Directory	00h	Page #0 (the Log Directory only has 1 512-byte page)
Host Specific (see A.10)	80h	Page #0 (first 512-byte log page)
		Page #1 (second 512-byte log page)
		...
		Page #15 (last 512-byte log page)
Host Specific	81h	Page #0 (first 512-byte log page)
		Page #1 (second 512-byte log page)
		...
		Page #15 (last 512-byte log page)
...		
Host Specific	9Fh	Page #0 (first 512-byte log page)
		Page #1 (second 512-byte log page)
		...
		Page #15 (last 512-byte log page)

Table A.2 — Log address definition

Log Address	Log Name	Feature Set	R/W	Access
00h	Log directory, see A.2 and A.3	N/A	RO	GPL,SL
01h	Summary SMART Error log, see A.17	SMART	RO	SL
02h	Comprehensive SMART Error log, see A.4	SMART	RO	SL
03h	Extended Comprehensive SMART Error log, see A.7	SMART	RO	GPL
04h	Device Statistics, see A.5	N/A	RO	GPL,SL
05h	Reserved for the CompactFlash Association.			
06h	SMART Self-Test log, see A.16	SMART	RO	SL
07h	Extended SMART Self-Test log, see A.9	SMART	RO	GPL
08h	Power Conditions, see A.8	EPC	RO	GPL
09h	Selective Self-Test log, see A.15	SMART	R/W	SL
0Ah-0Ch	Reserved	N/A	Reserved	
0Dh	LPS Mis-alignment log, see A.11	LPS	RO	GPL,SL
0Eh-0Fh	Reserved			
10h	NCQ Command Error log, see A.12	NCQ	RO	GPL
11h	SATA Phy Event Counters log, see A.14	N/A	RO	GPL
12h-17h	Reserved for Serial ATA	N/A	Reserved	
18h-1Fh	Reserved	N/A	Reserved	
20h	Obsolete			
21h	Write Stream Error log, see A.18	Streaming	RO	GPL
22h	Read Stream Error log, see A.13	Streaming	RO	GPL
23h	Obsolete			
24h-7Fh	Reserved	N/A	Reserved	
80h-9Fh	Host Specific, see A.10	SMART	R/W	GPL,SL
A0h-DFh	Device Vendor Specific, see A.6	SMART	VS	GPL,SL
E0h	SCT Command/Status, see 8.1	SCT	R/W	GPL,SL
E1h	SCT Data Transfer, see 8.1	SCT	R/W	GPL,SL
E2h-FFh	Reserved	N/A		

Key -
    RO - Log is read only.
    R/W - Log is read or written.
    VS - Log is vendor specific thus read/write ability is vendor specific.
    GPL - General Purpose Logging
    SL - SMART Logging

Note 1 - The device shall return command aborted if a GPL feature set command (see 4.11) accesses a log that is marked only with SL.
Note 2 - The device shall return command aborted if a SMART feature set command (see 4.23) accesses a log that is marked only with GPL.

A.2 General Purpose Log Directory (GPL Log Address 00h)

Table A.3 defines the 512 bytes that make up the General Purpose Log Directory.

Table A.3 — General Purpose Log Directory

Word	Description
0	General Purpose Logging Version (word)
1	Number of log pages at log address 01h (word)
2	Number of log pages at log address 02h (word)
3	Number of log pages at log address 03h (word)
4	Number of log pages at log address 04h (word)
…	
128	Number of log pages at log address 80h (word)
129	Number of log pages at log address 81h (word)
…	
255	Number of log pages at log address FFh (word)

The value of the General Purpose Logging Version word shall be 0001h.

A.3 SMART Log Directory (SMART Logging Log Address 00h)

Table A.4 defines the 512-bytes that make up the SMART Log Directory . The SMART Log Directory is defined as one log page.

Table A.4 — SMART Log Directory

Offset	Description
0..1	SMART Logging Version (word)
2	Number of log pages at log address 1
3	Reserved
4	Number of log pages at log address 2
5	Reserved
…	…
510	Number of log pages at log address 255
511	Reserved

The value of the SMART Logging Version word shall be 0001h if the device supports multi-block SMART logs.

If the device does not support multi-block SMART logs, then log address 00h is defined as reserved.

A.4 Comprehensive SMART Error log (Log Address 02h)

A.4.1 Overview

Table A.5 defines the format of each of the log pages that are part of the Comprehensive SMART Error log . The Comprehensive SMART Error log provides logging for 28-bit addressing only . For 48-bit addressing, see A.7 .

The maximum size of the Comprehensive SMART Error log shall be 51 log pages . Devices may support fewer than 51 log pages . The comprehensive error log data structures:

    a) shall include Uncorrectable errors;
    b) shall include ID Not Found errors for which the LBA requested was valid;
    c) shall include servo errors;
    d) shall include write fault errors; and
    e) other error conditions.

Comprehensive SMART Error log data structures shall not include errors attributed to the receipt of faulty commands (e.g., command codes not supported by the device or requests with invalid parameters or invalid LBAs).

Table A.5 — Comprehensive error log

Offset	First Log Page [b]	Subsequent Log Pages
0	SMART error log version	Reserved
1	Error log index	Reserved
2..91	First error log data structure	Data structure $5n^a+1$
92..181	Second error log data structure	Data structure $5n^a+2$
182..271	Third error log data structure	Data structure $5n^a+3$
272..361	Fourth error log data structure	Data structure $5n^a+4$
362..451	Fifth error log data structure	Data structure $5n^a+5$
452..453	Device error count	Reserved
454..510	Reserved	Reserved
511	Data structure checksum	Data structure checksum
[a] n is the nth log page within the log. [b] The first log page is numbered zero.		

A.4.2 Error log version

The value of the error log version byte shall be set to 01h.

A.4.3 Error log index

The error log index indicates the error log data structure representing the most recent error . If there have been no error log entries, then the error log index shall be set to zero . Valid values for the error log index are zero to 255.

A.4.4 Error log data structure

The error log is a circular buffer (i.e. . when the last supported error log block has been filled, the next error shall create an error log data structure that replaces the first error log data structure in page zero . The next error after that shall create an error log data structure that replaces the second error log data structure, etc.).

The device may support from two to 51 error log blocks.

The error log index indicates the most recent error log data structure . Unused error log data structures shall be filled with zeros.

The content of the error log data structure entries is defined in A.17.4.

A.4.5 Device error count

The Device Error Count field is defined in A.17.5.

A.4.6 Data structure checksum

The data structure checksum is defined in A.7.6.

A.5 Device Statistics log (Log Address 04h)

A.5.1 Overview

The optional Device Statistics log contains selected statistics about the device.

The number of log pages may be greater than one.

See table A.6 for a list of defined pages . Each supported page shall consist of a header field that may be followed by defined statistics fields . If the Revision Number field in the page header is 0000h, then that page is not supported . All page data following the last defined statistic for that page is reserved.

If an unsupported page is requested, then 512 bytes of all zeros shall be returned for that page.

Table A.6 — Defined Device Statistics pages

Page	Description
00h	List of supported pages (see A.5.2)
01h	General Statistics (see A.5.4)
02h	Free Fall Statistics (see A.5.3)
03h	Rotating Media Statistics (see A.5.6)
04h	General Errors Statistics (see A.5.8)
05h	Temperature Statistics (see A.5.8)
06h	Transport Statistics (see A.5.9)
07h	Solid State Device Statistics (see A.5.7)
08h..FFh	Reserved

Each statistic (see table A.7) shall:

    a)   be one QWord in length;
    b)   contain a Device Statistic Flag field (see table A.8); and
    c)   contain a Value field.

Table A.7 — Example Device Statistic

Bits	Field	Description
63:56	Flags	See table A.8
55:0	Value	The contents of the statistic itself.

Table A.8 — Device Statistic Flags

Bit	Field	F/V	Description
63	Supported	F	1 = This statistic is supported (i.e.,the other device statistic flags contain valid information).
			0 = This statistic is not supported (i.e.,the other statistic flags and the Value field in this statistic are N/A)
62	ValidValue	V	1 = The Value field for this statistic is valid.
			0 = The Value field for this statistic is not valid (e.g., it is numerically not accurate or it is not able to be retrieved by normal means).
			The ValidValue bit may be set to one or cleared to zero independent of the initialization of the Value field unless stated otherwise.
61	Normalized	F	This statistic may define a normalization algorithm.
			1 = The Value field contains a normalized value.
			0 = The Value field is not normalized.
60:56	Reserved		

Key:
F/V – Fixed/variable content
      F – The content of the field is fixed and does not change.
      V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.			

This standard describes the following for each statistic:

    a)   a name;
    b)   the location (i.e., byte offset from the beginning of the device statistic page);
    c)   a description of the meaning of the statistic, when and how the value changes, and whether the statistic is volatile;
    d)   a definition of bits within the value field;
    e)   an optional normalization algorithm;
    f)   update criteria;
    g)   the measurement units; and
    h)   initialization information.

The following update criteria apply to all supported statistics unless explicitly stated otherwise:

    a)   a set of all statistics shall reside in a non-volatile location;
    b)   the device may maintain a set of current statistics that is volatile . The current statistics may differ from those saved in non-volatile locations;
    c)   unless otherwise stated, if a Value field that increments reaches its maximum value, then the Value field shall remain at the maximum value;
    d)   for the device statistic pages read, the device shall save all statistics whose values have changed to a non-volatile location when the device processes a command to read the Device Statistics log;
    e)   the device shall save all statistics whose values have changed to a non-volatile location before entering PM2:Standby state (see 4.19.4) or any power management state (see 4.19.4) where the media is not accessible to the host;
    f)   there may be a statistic update timer that periodically causes a statistic to be copied to a non-volatile location;
    g)   if the device is in the PM3:Sleep state (see 4.19.4):
        A)   the current statistics shall not be updated to the non-volatile locations;
        B)   the statistic update timer shall not continue operation; and
        C)   the device shall not exit PM3:Sleep to update the non-volatile statistics;
    h)   if the device is in the PM2:Standby state (see 4.19.4):
        A)   the current statistics may be saved to the non-volatile locations;

B) if the statistics are saved to the non-volatile locations, then the statistic update timer shall be re-initialized and shall continue operation while in the PM2:Standby power management state;

C) if the statistics are not saved to the non-volatile locations, then the statistic update timer shall not continue operation while in the PM2:Standby power management state; and

D) the device shall not exit PM2:Standby to update the non-volatile statistics;

and

i) if the device is in the PM0:Active state or PM1:Idle state, then the specified statistic update timer shall be re-initialized when the current value is saved to a non-volatile location and:

A) when the statistic update timer expires and if a statistic value has not changed, then:

a) the statistic's value should not be saved; and

b) the specified statistic update timer is re-initialized when the statistic update timer expires;

or

B) if a statistic's value has changed, then:

a) if the statistic update timer expires and a command is not being processed, then the device shall save the statistic to a non-volatile location; or

b) if the statistic update timer expires during the processing of a command, then the statistic shall be updated either during command processing or after command completion . The statistic shall be updated before processing the next command.

A.5.2 List of Supported Device Statistics Pages (Page 00h)

The List of Supported Device Statistics Pages contains a list of the supported device statistics pages as described in Table 4 . If the Device Statistics log is supported and any device statistics page other than the General Statics page (see A.5.4) is supported, then this device statistics page shall be implemented . Entries shall be in order of ascending page number . Every page for which there is at least one supported statistic shall be listed.

Table A.9 — List of supported Device Statistics pages

Offset	Type	Description
0..7	QWord	Device Statistics Information Header . This device statistics page lists the numbers of the supported device statistics pages.
		Bit Description
		63:24 Reserved
		23:16 Page Number . Shall be set to 00h.
		15:0 Revision number . Shall be set to 0001h
8	Byte	Number of entries (n) in the following list
9	Byte	Page number of first supported device statistics page (00h)
10	Byte	Page number of second supported device statistics page
		...
n+8	Byte	Page number of nth supported device statistics page
n+9..511		Reserved

A.5.3 Free Fall Statistics (Page 02h)

A.5.3.1 Overview

The Free Fall Statistics page contains free-fall information as described in table A.10.

The Free Fall statistics are as follows:

a) Device Statistics Information Header;

b) Number of Free-Fall Events Detected; and

c) Overlimit Shock Events.

Table A.10 — Free Fall Statistics

Offset	Type	Description
0..7	QWord	Device Statistics Information Header
		Bit Description
		63:24 Reserved
		23:16 Page Number Shall be set to 02h
		15:0 Revision number Shall be set to 0001h
8..15	QWord	Number of Free-Fall Events Detected
		Bit Description
		63:56 Device Statistics Flags (see table A.8)
		55:32 Reserved
		31:0 Number of Free-Fall Events Detected (DWord)
16..23	QWord	Overlimit Shock Events
		Bit Description
		63:56 Device Statistics Flags (see table A.8)
		55:32 Reserved
		31:0 Number of shock events detected where the magnitude of the event exceeds the maximum rating of the device (DWord)
24..511	Byte	Reserved

A.5.3.2 Device Statistics Information Header

Device Statistics Information Header indicates the format of the structure (see table A.10) for this page.

A.5.3.3 Number of Free-Fall Events Detected

A.5.3.3.1 Description

The Number of Free-Fall Events Detected statistic is a counter that records the number of free-fall events detected by the device . This statistic is incremented by one for each free-fall event detected.

A.5.3.3.2 Update Interval

One hour.

A.5.3.3.3 Measurement Units

Events.

A.5.3.3.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.3.4 Overlimit Shock Events

A.5.3.4.1 Description

The Overlimit Shock Events statistic is a counter that records the number of shock events detected by the device with the magnitude higher than the maximum rating of the device . This statistic is incremented by one for each event detected.

A.5.3.4.2 Update Interval

One hour.

A.5.3.4.3 Measurement Units

Events.

A.5.3.4.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.4 General Statistics (Page 01h)

A.5.4.1 Overview

The General Statistics page contains general information about the device as described in table A.11.

The General Statistics statistics are as follows:

- a) Device Statistics Information Header;
- b) Lifetime Power-on Resets;
- c) Power-on Hours;
- d) Logical Sectors Written;
- e) Number of Write Commands;
- f) Logical Sectors Read; and
- g) Number of Read Commands.

Table A.11 — General Statistics (part 1 of 2)

Offset	Type	Description
0..7	QWord	Device Statistics Information Header (see A.5.4.2)
		Bit Description
		63:24 Reserved
		23:16 Page Number Shall be set to 01h.
		15:0 Revision number Shall be set to 0002h
8..15	QWord	Lifetime Power-On Resets (see A.5.4.3)
		Bit Description
		63:56 Device Statistics Flags (see table A.8).
		55:32 Reserved
		31:0 Number of times that the device has processed a Power-On Reset event (DWord)
16..23	QWord	Power-on Hours (see A.5.4.4)
		Bit Description
		63:32 Reserved
		31:0 Power-on Hours (DWord)

Table A.11 — General Statistics (part 2 of 2)

Offset	Type	Description
24..31	QWord	Logical Sectors Written (see A.5.4.5)
		Bit Description
		63:56 Device Statistics Flags (see table A.8)
		55:48 Reserved
		47:0 Logical Sectors Written
32..39	QWord	Number of Write Commands (see A.5.4.6)
		Bit Description
		63:56 Device Statistics Flags (see table A.8)
		55:48 Reserved
		47:0 Number of Write Commands
40..47	QWord	Logical Sectors Read (see A.5.4.7)
		Bit Description
		63:56 Device Statistics Flags (see table A.8)
		55:48 Reserved
		47:0 Logical Sectors Read
48..55	QWord	Number of Read Commands (see A.5.4.8)
		Bit Description
		63:56 Device Statistics Flags (see table A.8)
		55:48 Reserved
		47:0 Number of Read Commands
56..511	Byte	Reserved

A.5.4.2 Device Statistics Information Header

The Device Statistics Information Header indicates the format of the structure (see table A.11) for this page.

A.5.4.3 Lifetime Power-On Resets

A.5.4.3.1 Description

Lifetime Power-On Resets is a counter that records the number of times that the device has processed a power-on reset.

A.5.4.3.2 Update Interval

Lifetime Power-On Resets is incremented by one after processing each Power-On Reset and the device is capable of recording this statistic.

A.5.4.3.3 Measurement Units

Events.

A.5.4.3.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.4.4 Power-on Hours

A.5.4.4.1 Description

The Power-on Hours statistic is a value that records the amount of time that the device has been operational since the device was manufactured . The device:

   a)   shall increment this statistic when it is in PM0:Active state (see 4.19.4);
   b)   shall increment this statistic when it is in PM1:Idle state (see 4.19.4);
   c)   should increment this statistic when it is in the PM2:Standby state (see 4.19.4); and
   d)   shall not increment this statistic when it is in PM3:Sleep state (see 4.19.4).

This statistic is incremented in a volatile location with a resolution of one minute or less . This volatile value is accumulated into a non-volatile location per the update interval.

A.5.4.4.2 Update Interval

One hour.

A.5.4.4.3 Measurement Units

Hours.

A.5.4.4.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.4.5 Logical Sectors Written

A.5.4.5.1 Description

The Logical Sectors Written statistic is a value that records the number of logical sectors received from the host . This statistic is incremented by one for each logical sector that was successfully received from the host.

A.5.4.5.2 Update Interval

One hour.

A.5.4.5.3 Measurement Units

Logical sectors.

A.5.4.5.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.4.6 Number of Write Commands

A.5.4.6.1 Description

The Number of Write Commands statistic is the number of write commands that completed successfully . This statistic is incremented by one for each write command that successfully completes.

A.5.4.6.2 Update Interval

One hour.

A.5.4.6.3 Measurement Units

Events.

A.5.4.6.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.4.7 Logical Sectors Read

A.5.4.7.1 Description

The Logical Sectors Read statistic is a value that records the number of logical sectors sent to the host . This statistic is incremented by one for each logical sector that was successfully sent to the host.

A.5.4.7.2 Update Interval

One hour.

A.5.4.7.3 Measurement Units

Logical sectors.

A.5.4.7.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.4.8 Number of Read Commands

A.5.4.8.1 Description

The Number of Read Commands statistic is the number of read commands that completed successfully . This statistic is incremented by one for each read command that successfully completes.

A.5.4.8.2 Update Interval

One hour.

A.5.4.8.3 Measurement Units

Events.

A.5.4.8.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.5 General Errors Statistics (Page 04h)

A.5.5.1 Overview

General Errors Statistics page contains general error information about the device as described in table A.12.

The General Errors Statistics are as follows:

   a) Device Statistics Information Header;
   b) Number of Reported Uncorrectable Errors; and

c)   Number of Resets Between Command Acceptance and Command Completion.

Table A.12 — General Error Statistics

Offset	Type	Description		
0..7	QWord	Device Statistics Information Header		
			Bit	**Description**
			63:24	Reserved
			23:16	Page Number Shall be set to 04h.
			15:0	Revision number Shall be set to 0001h
8..15	QWord	Number of Reported Uncorrectable Errors (see A.5.5.3)		
			Bit	**Description**
			63:56	Device Statistics Flags (see table A.8).
			55:32	Reserved
			31:0	Number of Reported Uncorrectable Errors (DWord)
16..23	QWord	Number of Resets Between Command Acceptance and Command Completion (see A.5.5.4)		
			Bit	**Description**
			63:56	Device Statistics Flags (see table A.8)
			55:32	Reserved
			31:0	Number of Resets Between Command Acceptance and Command Completion (DWord)
24..511	Byte	Reserved		

A.5.5.2 Device Statistics Information Header

Device Statistics Information Header indicates the format of the structure (see table A.12) for this page.

A.5.5.3 Number of Reported Uncorrectable Errors

A.5.5.3.1 Description

The Number of Reported Uncorrectable Errors statistic is a counter that records the number of errors that are reported as an Uncorrectable Error (see 6.3.13) . This statistic shall be incremented by one for each event . Uncorrectable errors that occur during background activity shall not be counted . Uncorrectable errors reported by reads to flagged uncorrectable (see 7.78.2) logical blocks should not be counted.

A.5.5.3.2 Update Interval

One hour.

A.5.5.3.3 Measurement Units

Events.

A.5.5.3.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.5.4 Number of Resets Between Command Acceptance and Command Completion

A.5.5.4.1 Description

The Number of Resets Between Command Acceptance and Command Completion statistic is a counter that records the number of software reset or hardware reset events that occur when one or more commands have been accepted by the device but have not reached command completion . This statistic shall be incremented by one for each event.

A.5.5.4.2 Update Interval

One hour.

A.5.5.4.3 Measurement Units

Events.

A.5.5.4.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.6 Rotating Media Statistics (Page 03h)

A.5.6.1 Overview

The Rotating Media Statics page contains device rotating media information as described in table A.13.

The Rotating Media Statics statistics are as follows:

- a) Device Statistics Information Header;
- b) Spindle Motor Power-on Hours;
- c) Head Flying Hours;
- d) Head Loaded Events;
- e) Number of Reallocated Logical Sectors;
- f) Read Recovery Attempts; and
- g) Number of Mechanical Start Failures.

Table A.13 — Rotating Media Statistics

Offset	Type	Description
0..7	QWord	Device Statistics Information Header
		Bit Description
		63:24 Reserved
		23:16 Page Number Shall be set to 03h
		15:0 Revision number Shall be set to 0001h
8..15	QWord	Spindle Motor Power-on Hours (see A.5.6.3)
		Bit Description
		63:56 Device Statistics Flags (see table A.8).
		55:32 Reserved
		31:0 Spindle Motor Power-on Hours (DWord)
16..23	QWord	Head Flying Hours (see A.5.6.4)
		Bit Description
		63:56 Device Statistics Flags (see table A.8).
		55:32 Reserved
		31:0 Head Flying Hours (DWord)
24..31	QWord	Head Load Events (see A.5.6.5)
		Bit Description
		63:56 Device Statistics Flags (see table A.8).
		55:32 Reserved
		31:0 Head Load Events (DWord)
32..39	QWord	Number of Reallocated Logical Sectors (see A.5.6.6)
		Bit Description
		63:56 Device Statistics Flags (see table A.8).
		55:32 Reserved
		31:0 Number of Reallocated Logical Sectors (DWord)
40..47	QWord	Read Recovery Attempts (see A.5.6.7)
		Bit Description
		63:56 Device Statistics Flags (see table A.8).
		55:32 Reserved
		31:0 Read Recovery Attempts (DWord)
48..55	QWord	Number of Mechanical Start Failures (see A.5.6.8)
		Bit Description
		63:56 Device Statistics Flags (see table A.8).
		55:32 Reserved
		31:0 Number of Mechanical Start Failures (DWord)
56..511	Byte	Reserved

A.5.6.2 Device Statistics Information Header

Device Statistics Information Header indicates the format of the structure (see table A.13) for this page.

A.5.6.3 Spindle Motor Power-on Hours

A.5.6.3.1 Description

The Spindle Motor Power-on Hours statistic is a value that records the amount of time that the spindle motor has been powered on since the device was manufactured . This statistic is incremented in a volatile location with a resolution of one minute or less . This volatile value is accumulated into a non-volatile location per the update interval.

A.5.6.3.2 Update Interval

One hour.

A.5.6.3.3 Measurement Units

Hours.

A.5.6.3.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.6.4 Head Flying Hours

A.5.6.4.1 Description

The Head Flying Hours statistic is a value that records number of hours that the device heads have been flying over the surface of the media since the device was manufactured . This statistic is incremented in a volatile location with a resolution of one minute or less . This volatile value is accumulated into a nonvolatile location per the update interval.

A.5.6.4.2 Update Interval

One hour.

A.5.6.4.3 Measurement Units

Hours.

A.5.6.4.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.6.5 Head Load Events

A.5.6.5.1 Description

The Head Load Events statistic is a value that records the number of head load events . A head load event is defined as:

   a) when the heads are loaded from the ramp to the media for a ramp load device; or
   b) when the heads take off from the landing zone for a contact start stop device.

This statistic is incremented by one each time a head load event occurs.

A.5.6.5.2 Update Interval

One hour.

A.5.6.5.3 Measurement Units

Events.

A.5.6.5.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.6.6 Number of Reallocated Logical Sectors

The Number of Reallocated Logical Sectors statistic is a counter that records the number of logical sectors that have been reallocated after device manufacture . This statistic shall incremented by one for each logical sector.

A.5.6.6.1 Update Interval

One hour.

A.5.6.6.2 Measurement Units

Logical sectors.

A.5.6.6.3 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.6.7 Read Recovery Attempts

A.5.6.7.1 Description

Read Recovery Attempts is a counter that records the number of logical sectors that require three or more attempts to correctly read the data from the media for each read command . This statistic shall be incremented by one for each logical sector that encounters a read recovery attempt . These events may be caused by external environmental conditions (e.g., operating in a moving vehicle).

A.5.6.7.2 Update Interval

One hour.

A.5.6.7.3 Measurement Units

Events.

A.5.6.7.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.6.8 Number of Mechanical Start Failures

A.5.6.8.1 Description

The Number of Mechanical Start Failures statistic is a counter that records the number of mechanical start failures after device manufacture . A mechanical start failure is a failure that prevents the device from achieving

a normal operating condition . This statistic shall be incremented by one for each mechanical start failure event encountered.

A.5.6.8.2 Update Interval

One hour.

A.5.6.8.3 Measurement Units

Events.

A.5.6.8.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.7 Solid State Device Statistics (Page 07h)

A.5.7.1 Overview

The Solid State Device Statistics page contains solid state device information about the device as described in table A.14.

The Solid State Device Statistics are as follows:

   a) Device Statistics Information Header; and
   b) Percentage Used Endurance Indicator.

Table A.14 — Solid State Device Statistics

Offset	Type	Description		
0..7	QWord	Device Statistics Information Header		
			Bit	**Description**
			63:24	Reserved
			23:16	Page Number Shall be set to 06h.
			15:0	Revision number Shall be set to 0001h
8..15	QWord	Percentage Used Endurance Indicator (see A.5.7.3)		
			Bit	**Description**
			63:56	Device Statistics Flags (see table A.8).
			55:8	Reserved
			7:0	Percentage Used Endurance Indicator (Byte)
16..511	Byte	Reserved		

A.5.7.2 Device Statistics Information Header

Device Statistics Information Header indicates the format of the structure (see table A.14) for this page.

A.5.7.3 Percentage Used Endurance Indicator

A.5.7.3.1 Description

The Percentage Used Endurance Indicator is an vendor specific estimate of the percentage of device life used based on the actual device usage and the manufacturer's prediction of device life . A value of 100 indicates that

the estimated endurance of the device has been consumed, but may not indicate a device failure (e.g., minimum power-off data retention capability reached for devices using NAND flash technology) . The value is allowed to exceed 100 . The volatile value shall be updated once per power-on hour independent of the update interval specified below . Percentages greater than 254 shall be represented as 255.

A.5.7.3.2 Update Interval

One hour.

A.5.7.3.3 Measurement Units

Events.

A.5.7.3.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.8 Temperature Statistics (Page 05h)

A.5.8.1 Overview

The Temperature Statistics page contains general information about the device as described in table A.15 . The value in the temperature field is a two's complement integer in degrees Celsius.

The Temperature Statistics are as followed:

  a) Device Statistics Information Header;
  b) Current Temperature;
  c) Average Short Term Temperature;
  d) Average Long Term Temperature;
  e) Highest Temperature;
  f) Lowest Temperature;
  g) Highest Average Short Term Temperature;
  h) Lowest Average Short Term Temperature;
  i) Highest Average Long Term Temperature;
  j) Lowest Average Long Term Temperature;
  k) Time in Over-Temperature;
  l) Specified Maximum Operating Temperature;
  m) Time in Under-Temperature; and
  n) Specified Minimum Operating Temperature.

Table A.15 — Temperature Statistics (part 1 of 3)

Offset	Type	Description
0..7	QWord	Device Statistics Information Header
		Bit Description
		63:24 Reserved
		23:16 Page Number Shall be set to 05h
		15:0 Revision number Shall be set to 0001h

Table A.15 — Temperature Statistics (part 2 of 3)

Offset	Type	Description		
8..15	QWord	Current Temperature (see A.5.8.3)		
			Bit	**Description**
			63:56	Device Statistics Flags (see table A.8)
			55:8	Reserved
			7:0	Current Temperature (signed byte)
16..23	QWord	Average Short Term Temperature (see A.5.8.4)		
			Bit	**Description**
			63:56	Device Statistics Flags (see table A.8)
			55:8	Reserved
			7:0	Average Short Term Temperature (signed byte)
24..31	QWord	Average Long Term Temperature (see A.5.8.5)		
			Bit	**Description**
			63:56	Device Statistics Flags (see table A.8)
			55:8	Reserved
			7:0	Average Long Term Temperature (signed byte)
32..39	QWord	Highest Temperature (see A.5.8.6)		
			Bit	**Description**
			63:56	Device Statistics Flags (see table A.8)
			55:8	Reserved
			7:0	Highest Temperature (signed byte)
40..47	QWord	Lowest Temperature (see A.5.8.7)		
			Bit	**Description**
			63:56	Device Statistics Flags (see table A.8)
			55:8	Reserved
			7:0	Lowest Temperature (signed byte)
48..55	QWord	Highest Average Short Term Temperature (see A.5.8.8)		
			Bit	**Description**
			63:56	Device Statistics Flags (see table A.8).
			55:8	Reserved
			7:0	Highest Average Short Term Temperature (signed byte)
56..63	QWord	Lowest Average Short Term Temperature (see A.5.8.9)		
			Bit	**Description**
			63:56	Device Statistics Flags (see table A.8)
			55:8	Reserved
			7:0	Lowest Average Short Term Temperature (signed byte)
64..71	QWord	Highest Average Long Term Temperature (see A.5.8.10)		
			Bit	**Description**
			63:56	Device Statistics Flags (see table A.8)
			55:8	Reserved
			7:0	Highest Average Long Term Temperature (signed byte)

Table A.15 — Temperature Statistics (part 3 of 3)

Offset	Type	Description		
72..79	QWord	Lowest Average Long Term Temperature (see A.5.8.11)		
		Bit	**Description**	
		63:56	Device Statistics Flags (see table A.8)	
		55:8	Reserved	
		7:0	Lowest Average Long Term Temperature (signed byte)	
80..87	QWord	Time in Over-Temperature (see A.5.8.12)		
		Bit	**Description**	
		63:56	Device Statistics Flags (see table A.8)	
		55:32	Reserved	
		31:0	Time in Over-Temperature (DWord)	
88..95	QWord	Specified Maximum Operating Temperature (see A.5.8.13)		
		Bit	**Description**	
		63:56	Device Statistics Flags (see table A.8)	
		55:8	Reserved	
		7:0	Specified Maximum Operating Temperature (signed byte)	
96..103	QWord	Time in Under-Temperature (see A.5.8.14)		
		Bit	**Description**	
		63:56	Device Statistics Flags (see table A.8)	
		55:32	Reserved	
		31:0	Time in Under-Temperature (DWord)	
104..111	QWord	Specified Minimum Operating Temperature (see A.5.8.15)		
		Bit	**Description**	
		63:56	Device Statistics Flags (see table A.8)	
		55:8	Reserved	
		7:0	Specified Minimum Operating Temperature (signed byte)	
112..511	Byte	Reserved		

A.5.8.2 Device Statistics Information Header

Device Statistics Information Header indicates the format of the structure (see table A.15) for this page.

A.5.8.3 Current Temperature

A.5.8.3.1 Description

The Current Temperature statistic is the temperature measured by the device at the time this log page is read.

A.5.8.3.2 Update Interval

None.

A.5.8.3.3 Measurement Units

Degrees Celsius.

A.5.8.3.4 Initialization

None.

A.5.8.4 Average Short Term Temperature

A.5.8.4.1 Description

The Average Short Term Temperature statistic is a value based on the most recent 144 temperature samples in a 24 hour period . The device enters the current temperature sample into the Average Short Term Temperature FIFO once every nominal ten minutes period . The Average Short Term Temperature FIFO consists of at least 144 temperature entries (i.e., 24 recorded hours) . This statistic is calculated by averaging the last 144 Average Short Term Temperature FIFO entries.

A.5.8.4.2 Update Interval

One hour.

A.5.8.4.3 Measurement Units

Degrees Celsius.

A.5.8.4.4 Initialization

This statistic is not initialized at the time of manufacture . The ValidValue bit shall not be set to one and the data in bits (7:0) are not valid until after the device collects 144 temperature samples.

A.5.8.5 Average Long Term Temperature

A.5.8.5.1 Description

The Average Long Term Temperature statistic is a value based on the most recent 42 Average Short Term Temperature values . The device enters the current value of the Average Short Term Temperature into the Average Long Term Temperature FIFO once every nominal 24 hour period . The Average Long Term Temperature FIFO consists of at least 42 temperature entries (i.e., 1 008 recorded hours) . This statistic is calculated by averaging the last 42 Average Long Term Temperature FIFO entries.

A.5.8.5.2 Update Interval

One hour.

A.5.8.5.3 Measurement Units

Degrees Celsius

A.5.8.5.4 Initialization

This statistic is not initialized at the time of manufacture . The ValidValue bit shall not be set to one and the data in bits (7:0) are not valid until after the device collects 42 Average Short Term Temperature data samples.

A.5.8.6 Highest Temperature

A.5.8.6.1 Description

The Highest Temperature statistic is the highest temperature measured after the device is manufactured . This data is calculated by comparing the current temperature value and the Highest Temperature value and storing

the higher value . The comparison shall occur when a new temperature value is entered into the Average Short Term Temperature FIFO.

A.5.8.6.2 Update Interval

One hour.

A.5.8.6.3 Measurement Units

Degrees Celsius.

A.5.8.6.4 Initialization

This statistic is not initialized at the time of manufacture . The ValidValue bit shall not be set to one and the data in bits (7:0) are not valid until after the device collects the first Average Short Term Temperature data sample.

A.5.8.7 Lowest Temperature

A.5.8.7.1 Description

The Lowest Temperature statistic is the lowest temperature measured after the device is manufactured . This data is calculated by comparing the current temperature value and the Lowest Temperature value and storing the lower value . The comparison shall occur when a new temperature value is entered into the Average Short Term Temperature FIFO.

A.5.8.7.2 Update Interval

One hour.

A.5.8.7.3 Measurement Units

Degrees Celsius.

A.5.8.7.4 Initialization

This statistic is not initialized at the time of manufacture . The ValidValue bit shall not be set to one and the data in bits (7:0) are not valid until after the device collects the first Average Short Term Temperature data sample.

A.5.8.8 Highest Average Short Term Temperature

A.5.8.8.1 Description

The Highest Average Short Term Temperature statistic is a value that records the highest device Average Short Term Temperature after the device is manufactured . This data is calculated by comparing the current Average Short Term Temperature value and the Highest Average Short Term Temperature value and storing the higher value.

A.5.8.8.2 Update Interval

One hour.

A.5.8.8.3 Measurement Units

Degrees Celsius.

A.5.8.8.4 Initialization

This statistic is not initialized at the time of manufacture . The ValidValue bit shall not be set to one and the data in bits (7:0) are not valid until after the device collects 144 temperature samples.

A.5.8.9 Lowest Average Short Term Temperature

A.5.8.9.1 Description

The Lowest Average Short Term Temperature statistic is a value that records the lowest device Average Short Term Temperature after the device is manufactured . This data is calculated by comparing the current Average Short Term Temperature value and the Lowest Average Short Term Temperature value and storing the lower value.

A.5.8.9.2 Update Interval

One hour.

A.5.8.9.3 Measurement Units

Degrees Celsius.

A.5.8.9.4 Initialization

This statistic is not initialized at the time of manufacture . The ValidValue bit shall not be set to one and the data in bits (7:0) are not valid until after the device collects 144 temperature samples.

A.5.8.10 Highest Average Long Term Temperature

A.5.8.10.1 Description

The Highest Average Long Term Temperature statistic is a value that records the highest device Average Long Term Temperature after the device is manufactured . This data is calculated by comparing the current Average Long Term Temperature value and the Highest Average Long Term Temperature value and storing the higher value.

A.5.8.10.2 Update Interval

One hour.

A.5.8.10.3 Measurement Units

Degrees Celsius

A.5.8.10.4 Initialization

This statistic is not initialized at the time of manufacture . The ValidValue bit shall not be set to one and the data in bits (7:0) are not valid until after the device collects 42 Average Short Term Temperature data samples.

A.5.8.11 Lowest Average Long Term Temperature

A.5.8.11.1 Description

The Lowest Average Long Term Temperature statistic is a value that records the lowest device Average Long Term Temperature after the device is manufactured . This data is calculated by comparing the current Average Long Term Temperature value and the Lowest Average Long Term Temperature value and storing the lower value.

A.5.8.11.2 Update Interval

One hour.

A.5.8.11.3 Measurement Units

Degrees Celsius

A.5.8.11.4 Initialization

This statistic is not initialized at the time of manufacture . The ValidValue bit shall not be set to one and the data in bits (7:0) are not valid until after the device collects 42 Average Short Term Temperature data samples.

A.5.8.12 Time in Over-Temperature

A.5.8.12.1 Description

The Time in Over-Temperature statistic is a value that records the nominal amount of time that the device has been operational in an environment that exceeds the device's specified Maximum Operating Temperature (see A.5.8.13) since the device was manufactured.

The nominal sampling time of the temperature is ten minutes . This statistic is calculated by adding ten minutes for each sample taken that exceeds the temperature limit . This statistic is recorded in minutes of over-temperature operation . This statistic records the number of minutes that the device has been operational while the device temperature specification has been exceeded.

A.5.8.12.2 Update Interval

One hour.

A.5.8.12.3 Measurement Units

Minutes.

A.5.8.12.4 Initialization

This statistic shall be initialized to zero at the time of manufacture.

A.5.8.13 Specified Maximum Operating Temperature

A.5.8.13.1 Description

The Specified Maximum Operating Temperature is a value that reports the maximum operating temperature device is designed to operate . This value is used for the calculation of the Time in Over-Temperature statistic.

A.5.8.13.2 Update Interval

None.

A.5.8.13.3 Measurement Units

Degrees Celsius.

A.5.8.13.4 Initialization

This value shall be set at the time of manufacture.

A.5.8.14 Time in Under-Temperature

A.5.8.14.1 Description

The Time in Under-Temperature statistic is a value that records the nominal amount of time that the device has been operational in an environment that goes below the device's specified minimum operating temperature (see A.5.8.15) since the device was manufactured.

The nominal sampling time of the temperature is ten minutes . This statistic is calculated by adding ten minutes for each sample taken that goes below the temperature limit . This statistic is recorded in minutes of over-temperature operation . This statistic records the number of minutes that the device has been operational while the temperature is lower than the device minimum temperature specification.

A.5.8.14.2 Update Interval

One hour.

A.5.8.14.3 Measurement Units

Minutes.

A.5.8.14.4 Initialization

This statistic shall be initialized to zero at the time of manufacture.

A.5.8.15 Specified Minimum Operating Temperature

A.5.8.15.1 Description

The Specified Minimum Operating Temperature is a value that reports the minimum operating temperature device is designed to operate . This value is used for the calculation of the Time in Under-Temperature statistic.

A.5.8.15.2 Update Interval

None.

A.5.8.15.3 Measurement Units

Degrees Celsius.

A.5.8.15.4 Initialization

This value shall be set at the time of manufacture.

A.5.9 Transport Statistics (Page 06h)

A.5.9.1 Overview

The Transport Statistics page contains interface transport information about the device as described in table A.16.

The Transport Statistics are as follows:

    a) Device Statistics Information Header;
    b) Number of hardware resets;
    c) Number of ASR Events; and

d)   Number of Interface CRC Errors.

Table A.16 — Transport Statistics

Offset	Type	Description
0..7	QWord	Device Statistics Information Header
		Bit Description
		63:24 Reserved
		23:16 Page Number Shall be set to 06h.
		15:0 Revision number Shall be set to 0001h
8..15	QWord	Number of hardware resets (see A.5.9.3)
		Bit Description
		63:56 Device Statistics Flags (see table A.8).
		55:32 Reserved
		31:0 Number of hardware resets (DWord)
16..23	QWord	Number of ASR Events (see A.5.9.4)
		Bit Description
		63:56 Device Statistics Flags (see table A.8)
		55:32 Reserved
		31:0 Number of ASR Events (DWord)
24..31	QWord	Number of Interface CRC Errors (see A.5.9.5)
		Bit Description
		63:56 Device Statistics Flags (see table A.8)
		55:32 Reserved
		31:0 Number of Interface CRC Errors (DWord)
32..511	Byte	Reserved

A.5.9.2 Device Statistics Information Header

Device Statistics Information Header indicates the format of the structure (see table A.16) for this page.

A.5.9.3 Number of hardware resets

A.5.9.3.1 Description

The Number of hardware resets statistic is the number of hardware resets received by the device . This statistic is incremented by one for each hardware reset . For SATA devices, this includes all COMRESETs regardless of whether the Software Settings Preservation feature set (see 4.25) is enabled or not.

A.5.9.3.2 Update Interval

Ten minutes.

A.5.9.3.3 Measurement Units

Events.

A.5.9.3.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.9.4 Number of ASR Events

A.5.9.4.1 Description

The Number of ASR Events statistic is a counter that records the number of ASR events (see SATA 2.6) . This statistic is incremented by one for each ASR event detected.

A.5.9.4.2 Update Interval

Ten minutes.

A.5.9.4.3 Measurement Units

Events.

A.5.9.4.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.9.5 Number of Interface CRC Errors

A.5.9.5.1 Description

The Number of Interface CRC Errors statistic is a counter that records the number of Interface CRC errors (see 6.3.10) reported in the Error field since the device was manufactured . This statistic is incremented by one for each Interface CRC error reported in the Error field.

A.5.9.5.2 Update Interval

Ten minutes.

A.5.9.5.3 Measurement Units

Events.

A.5.9.5.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.10 Reserved (Page 08h..FFh)

A.6 Device Vendor Specific logs (Log Addresses A0h-DFh)

Support for Device Vendor Specific logs is optional . Device Vendor Specific logs may be used by the device vendor to store any data and need only be implemented if used.

A.7 Extended Comprehensive SMART Error log (Log Address 03h)

A.7.1 Overview

Table A.17 defines the format of each of the log pages that define the Extended Comprehensive SMART Error log . The maximum size of the Extended Comprehensive SMART Error log is 16 383 log pages . Devices may support fewer than 16 383 log pages . Error log data structures shall include, but are not limited to, Uncorrectable errors (see 6.3.13), ID Not Found errors (see 6.3.6) for which the LBA requested was valid, servo errors, and write fault errors . Error log data structures shall not include errors attributed to the receipt of faulty commands (e.g., command codes not implemented by the device or requests with invalid parameters or invalid LBAs) .

All 28-bit entries contained in the Comprehensive SMART log (see A.4), shall also be included in the Extended Comprehensive SMART Error log with the 48-bit entries.

Table A.17 — Extended Comprehensive SMART Error log

Offset	First Log Page [b]	Subsequent Log Pages
0	SMART error log version	Reserved
1	Reserved	Reserved
2..3	Error log index (word)	Reserved
4..127	First error log data structure	Data structure $4n^a+1$
128..251	Second error log data structure	Data structure $4n^a+2$
252..375	Third error log data structure	Data structure $4n^a+3$
376..499	Fourth error log data structure	Data structure $4n^a+4$
500..501	Device error count (word)	Reserved
502..510	Reserved	Reserved
511	Data structure checksum	Data structure checksum
[a] n is the logical log page number within the log. [b] The first log page is numbered zero.		

A.7.2 Error log version

The value of the SMART error log version byte shall be 01h.

A.7.3 Error log index

The error log index is the error log data structure number representing the most recent error . If there have been no error log entries, the error log index is cleared to zero.

A.7.4 Extended Error log data structure

A.7.4.1 Overview

The Extended Comprehensive SMART Error log is viewed as a circular buffer . The error log index indicates the most recent error log data structure . Unused error log data structures shall be filled with zeros.

The content of the error log data structure entries is defined in Table A.18.

Table A.18 — Extended Error log data structure

Offset	Description
n..n+17	First command data structure
n+18..n+35	Second command data structure
n+36..n+53	Third command data structure
n+54..n+71	Fourth command data structure
n+72..n+89	Fifth command data structure
n+90..n+123	Error data structure

A.7.4.2 Command data structure

The extended error log data structure is filled as follows:

1) the fifth command data structure shall contain the command or reset for which the error is being reported;
2) the fourth command data structure should contain the command or reset that preceded the command or reset for which the error is being reported;
3) the third command data structure should contain the command or reset preceding the one in the fourth command data structure;
4) the second command data structure should contain the command or reset preceding the one in the third command data structure; and
5) the first command data structure should contain the command or reset preceding the one in the second command data structure.

If fewer than four commands and resets preceded the command or reset for which the error is being reported, the unused command data structures shall be zero filled (e.g., if only three commands and resets preceded the command or reset for which the error is being reported, the first command data structure shall be zero filled) . Devices that are not able to report the commands that preceded the command for which the error is being reported or that preceded a reset shall zero fill the command data structures.

If the command data structure represents a command or software reset, then the content of the command data structure shall be as shown in Table A.19 . If the command data structure represents a hardware reset, then the

content of byte n shall be FFh, the content of bytes n+1 through n+13 are vendor specific, and the content of bytes n+14 through n+17 shall contain the timestamp.

Table A.19 — Command data structure

Offset	Description
n	Content of the Device Control field when the Command was initiated.
n+1	Content of the Feature field (7:0) when the Command was initiated.
n+2	Content of the Feature field (15:8) when the Command was initiated .
n+3	Content of the Count field (7:0) when the Command was initiated.
n+4	Content of the Count field (15:8) when the Command was initiated.
n+5	Content of the LBA field (7:0) when the Command was initiated.
n+6	Content of the LBA field (31:24) when the Command was initiated.
n+7	Content of the LBA field (15:8) when the Command was initiated.
n+8	Content of the LBA field (39:32) when the Command was initiated.
n+9	Content of the LBA field (23:16) when the Command was initiated.
n+10	Content of the LBA field (47:40) when the Command was initiated.
n+11	Content of the Device field when the Command was initiated.
n+12	Content written to the Command field when the command was initiated
n+13	Reserved
n+14..n+17	Timestamp (DWord) shall be the time since power-on in milliseconds when command acceptance occurred . This timestamp may wrap.

A.7.4.3 Error data structure

The error data structure shall contain the error description of the command for which an error was reported as described in Table A.20 . If the error was logged for a hardware reset, the content of bytes n+1 through n+11 shall be vendor specific and the remaining bytes shall be as defined in Table A.20.

Table A.20 — Error data structure

Offset	Description
n	Transport specific value when the Command was initiated . See the appropriate transport standard, reference Device Control field.
n+1	Content of the Error field (7:0) after command completion occurred.
n+2	Content of the Count field (7:0) after command completion occurred.
n+3	Content of the Count field (15:8) after command completion occurred.
n+4	Content of the LBA field (7:0) when the command completion occurred.
n+5	Content of the LBA field (31:24) when the command completion occurred.
n+6	Content of the LBA field (15:8) when the command completion occurred.
n+7	Content of the LBA field (39:32) when the command completion occurred.
n+8	Content of the LBA field (23:16) when the command completion occurred.
n+9	Content of the LBA field (47:40) when the command completion occurred.
n+10	Content of the Device field after command completion occurred.
n+11	Content written to the Status field after command completion occurred.
n+12..n+30	Extended error information
n+31	State
n+32..n+33	Life timestamp (word)

Extended error information shall be vendor specific.

State shall contain a value indicating the state of the device when the command was initiated or the reset occurred as described in Table A.21.

Table A.21 — State field values

Value [a]	State
x0h	Unknown
x1h	Sleep
x2h	Standby
x3h	Active/Idle
x4h	Executing SMART off-line or self-test
x5h-xAh	Reserved
xBh-xFh	Vendor specific
[a] The value of x is vendor specific and may be different for each state.	

Sleep indicates the reset for which the error being reported was received when the device was in the Sleep mode.

Standby indicates the command or reset for which the error being reported was received when the device was in the Standby mode.

Active/Idle indicates the command or reset for which the error being reported was received when the device was in the Active or Idle mode.

Executing SMART off-line or self-test indicates the command or reset for which the error being reported was received when the device was processing a SMART off-line or self-test.

Life timestamp shall contain the power-on lifetime of the device in hours when command completion occurred.

A.7.5 Device error count

The Device Error Count field shall contain the total number of errors attributable to the device that have been reported by the device during the life of the device (e.g., Uncorrectable errors (see 6.3.13), ID Not Found errors (see 6.3.6) for which the LBA requested was valid, servo errors, write fault errors) . This device error count shall not include errors attributed to the receipt of faulty commands (e.g., command codes not implemented by the device or requests with invalid parameters or invalid LBAs) . If the maximum value for this field is reached, then the count shall remain at the maximum value when additional errors are encountered and logged.

A.7.6 Data structure checksum

The data structure checksum is the two's complement of the sum of the first 511 bytes in the data structure . Each byte shall be added with unsigned arithmetic, and overflow shall be ignored . The sum of all 512 bytes shall be zero when the checksum is correct . The checksum is placed in byte 511.

A.8 Power Conditions log (Log Address 08h)

Table A.22 defines the Power Conditions log . If the Extended Power Conditions feature set (see 4.9) is not supported, then the Power Conditions log shall not be supported.

Table A.22 — Power Conditions Log (part 1 of 9)

Offset	Type	Description

0..1	Word	Idle_a Power Condition Flags
		
		Bit Description
		
		15 Power Condition Supported
		Power condition supported shall be set to one to indicate that the Idle_a power condition (see 4.9.2) is supported.
		
		14 Timer Saveable
		    1= Idle_a timer is saveable (see 7.50.19.4)
		    0= Idle_a timer is not saveable
		
		13 Timer Changeable
		    1= Idle_a timer is changeable
		    0= Idle_a timer is not changeable
		
		12 Default Timer Enabled
		    1= Default Idle_a timer is enabled
		    0= Default Idle_a timer is disabled
		
		11 Saved Timer Enabled
		    1= Saved Idle_a timer is enabled
		    0= Saved Idle_a timer is disabled
		
		10 Current Timer Enabled
		    1= Current Idle_a timer is enabled
		    0= Current Idle_a timer is disabled
		
		9:0 Reserved

2..3	Word	Reserved

Table A.22 — Power Conditions Log (part 2 of 9)

Offset	Type	Description
4..7	DWord	Default Idle_a Timer setting The Default Idle_a Timer setting is the minimum time that the device shall wait after command completion before entering the Idle_a power condition of the PM1:Idle power management state (see 4.19.4) . A value of zero indicates that this power condition is disabled . A value of FFFF_FFFFh indicates that the time is greater than or equal to 429 496 729 500 milliseconds. Measurement Units: 100 milliseconds.
8..11	DWord	Saved Idle_a Timer setting The Saved Idle_a Timer setting is the minimum time that the device shall wait after command completion before entering the Idle_a power condition of the PM1:Idle power management state . A value of zero indicates that this power condition is disabled . A value of FFFF_FFFFh indicates that the time is greater than or equal to 429 496 729 500 milliseconds. Measurement Units: 100 milliseconds.
12..15	DWord	Current Idle_a Timer setting The Current Idle_a Timer setting is the minimum time that the device shall wait after command completion before entering the Idle_a power condition of the PM1:Idle power management state . A value of zero indicates that this power condition is disabled . A value of FFFF_FFFFh indicates that the time is greater than or equal to 429 496 729 500 milliseconds. Measurement Units: 100 milliseconds
16..19	DWord	Nominal Recovery time from Idle_a to PM0:Active power management state The Nominal Recovery time from Idle_a to PM0:Active is the nominal time required to transition from Idle_a to PM0:Active power management state (see 4.9.2) . This time does not include processing time for the command that caused this transition to occur . A value of zero indicates that the nominal recovery time is not specified . A value of FFFF_FFFFh indicates that the recovery time is greater than or equal to 429 496 729 500 milliseconds. Measurement Units: 100 milliseconds. This value shall be preserved over all resets.
20..23	DWord	Minimum Idle_a timer setting The Minimum Idle_a timer setting is the minimum timer value allowed by the Set Power Condition Timer subcommand (see 7.50.19.4) for the Idle_a timer . A value of zero indicates that the minimum timer value is not specified . A value of FFFF_FFFFh indicates that the minimum timer value is greater than or equal to 429 496 729 500 milliseconds. Measurement Units: 100 milliseconds This value shall be preserved over all resets
24..27	DWord	Maximum Idle_a timer setting The Maximum Idle_a timer setting is the maximum timer value allowed by the Set Power Condition Timer subcommand for the Idle_a timer . A value of zero indicates that the maximum timer value is not specified . A value of FFFF_FFFFh indicates that the maximum timer value is greater than or equal to 429 496 729 500 milliseconds. Measurement Units: 100 milliseconds This value shall be preserved over all resets
28..31	DWord	Reserved

Table A.22 — Power Conditions Log (part 3 of 9)

Offset	Type	Description

32..33	Word	Idle_b Power Condition Flags
		
		Bit Description
		
		15 Power Condition Supported
		    1= Idle_b power condition (see 4.9.2) is supported
		    0= Idle_b power condition is not supported
		
		14 Timer Saveable
		    1= Idle_b timer is saveable (see 7.50.19.4)
		    0= Idle_b timer is not saveable
		
		13 Timer Changeable
		    1= Idle_b timer is changeable
		    0= Idle_b timer is not changeable
		
		12 Default Timer Enabled
		    1= Default Idle_b timer is enabled
		    0= Default Idle_b timer is disabled
		
		11 Saved Timer Enabled
		    1= Saved Idle_b timer is enabled
		    0= Saved Idle_b timer is disabled
		
		10 Current Timer Enabled
		    1= Current Idle_b timer is enabled
		    0= Current Idle_b timer is disabled
		
		9:0 Reserved

34..35	Word	Reserved
36..39	DWord	Default Idle_b Timer setting The Default Idle_b Timer setting is the minimum time that the device shall wait after command completion before entering the Idle_b power condition of the PM1:Idle power management state (see 4.19.4) . A value of zero indicates that this power condition is disabled . A value of FFFF_FFFFh indicates that the time is greater than or equal to 429 496 729 500 milliseconds. Measurement Units: 100 milliseconds.
40..43	DWord	Saved Idle_b Timer setting The Saved Idle_b Timer setting is the minimum time that the device shall wait after command completion before entering the Idle_b power condition of the PM1:Idle power management state . A value of zero indicates that this power condition is disabled . A value of FFFF_FFFFh indicates that the time is greater than or equal to 429 496 729 500 milliseconds. Measurement Units: 100 milliseconds.
44..47	DWord	Current Idle_b Timer setting The Current Idle_b Timer setting is the minimum time that the device shall wait after command completion before entering the Idle_b power condition of the PM1:Idle power management state . A value of zero indicates that this power condition is disabled . A value of FFFF_FFFFh indicates that the time is greater than or equal to 429 496 729 500 milliseconds. Measurement Units: 100 milliseconds

Table A.22 — Power Conditions Log (part 4 of 9)

Offset	Type	Description
48..51	DWord	Nominal Recovery time from Idle_b to PM0:Active power management state
		The Nominal Recovery time from Idle_b to PM0:Active is the nominal time required to transition from Idle_b to PM0:Active power management state (see 4.9.2) . This time does not include processing time for the command that caused this transition to occur . A value of zero indicates that the nominal recovery time is not specified . A value of FFFF_FFFFh indicates that the recovery time is greater than or equal to 429 496 729 500 milliseconds.
		Measurement Units: 100 milliseconds.
		This value shall be preserved over all resets.
52..55	DWord	Minimum Idle_b timer setting
		The Minimum Idle_b timer setting is the minimum timer value allowed by the Set Power Condition Timer subcommand (see 7.50.19.4) for the Idle_b timer . A value of zero indicates that the minimum timer value is not specified . A value of FFFF_FFFFh indicates that the minimum timer value is greater than or equal to 429 496 729 500 milliseconds.
		Measurement Units: 100 milliseconds
		This value shall be preserved over all resets
56..59	DWord	Maximum Idle_b timer setting
		The Maximum Idle_b timer setting is the maximum timer value allowed by the Set Power Condition Timer subcommand for the Idle_b timer . A value of zero indicates that the maximum timer value is not specified . A value of FFFF_FFFFh indicates that the maximum timer value is greater than or equal to 429 496 729 500 milliseconds.
		Measurement Units: 100 milliseconds
		This value shall be preserved over all resets
60..63	DWord	Reserved
64..65	Word	Idle_c Power Condition Flags
		Bit Description

		15 Power Condition Supported
		        1= Idle_c power condition (see 4.9.2) is supported
		        0= Idle_c power condition is not supported

		14 Timer Saveable
		        1= Idle_c timer is saveable (see 7.50.19.4)
		        0= Idle_c timer is not saveable

		13 Timer Changeable
		        1= Idle_c timer is changeable
		        0= Idle_c timer is not changeable

		12 Default Timer Enabled
		        1= Default Idle_c timer is enabled
		        0= Default Idle_c timer is disabled

		11 Saved Timer Enabled
		        1= Saved Idle_c timer is enabled
		        0= Saved Idle_c timer is disabled

		10 Current Timer Enabled
		        1= Current Idle_c timer is enabled
		        0= Current Idle_c timer is disabled

		9:0 Reserved
66..67	Word	Reserved

Table A.22 — Power Conditions Log (part 5 of 9)

Offset	Type	Description
68..71	DWord	Default Idle_c Timer setting The Default Idle_c Timer setting is the minimum time that the device shall wait after command completion before entering the Idle_c power condition of the PM1:Idle power management state (see 4.19.4) . A value of zero indicates that this power condition is disabled . A value of FFFF_FFFFh indicates that the time is greater than or equal to 429 496 729 500 milliseconds. Measurement Units: 100 milliseconds.
72..75	DWord	Saved Idle_c Timer setting The Saved Idle_c Timer setting is the minimum time that the device shall wait after command completion before entering the Idle_c power condition of the PM1:Idle power management state (see 4.9.2) . A value of zero indicates that this power condition is disabled . A value of FFFF_FFFFh indicates that the time is greater than or equal to 429 496 729 500 milliseconds. Measurement Units: 100 milliseconds.
76..79	DWord	Current Idle_c Timer setting The Current Idle_c Timer setting is the minimum time that the device shall wait after command completion before entering the Idle_c power condition of the PM1:Idle power management state . A value of zero indicates that this power condition is disabled . A value of FFFF_FFFFh indicates that the time is greater than or equal to 429 496 729 500 milliseconds. Measurement Units: 100 milliseconds
80..83	DWord	Nominal Recovery time from Idle_c to PM0:Active power management state The Nominal Recovery time from Idle_c to PM0:Active is the nominal time required to transition from Idle_c to PM0:Active power management state (see 4.9.2) . This time does not include processing time for the command that caused this transition to occur . A value of zero indicates that the nominal recovery time is not specified . A value of FFFF_FFFFh indicates that the recovery time is greater than or equal to 429 496 729 500 milliseconds. Measurement Units: 100 milliseconds. This value shall be preserved over all resets.
84..87	DWord	Minimum Idle_c timer setting The Minimum Idle_c timer setting is the minimum timer value allowed by the Set Power Condition Timer subcommand (see 7.50.19.4) for the Idle_c timer . A value of zero indicates that the minimum timer value is not specified . A value of FFFF_FFFFh indicates that the minimum timer value is greater than or equal to 429 496 729 500 milliseconds. Measurement Units: 100 milliseconds This value shall be preserved over all resets
88..91	DWord	Maximum Idle_c timer setting The Maximum Idle_c timer setting is the maximum timer value allowed by the Set Power Condition Timer subcommand for the Idle_c timer . A value of zero indicates that the maximum timer value is not specified . A value of FFFF_FFFFh indicates that the maximum timer value is greater than or equal to 429 496 729 500 milliseconds. Measurement Units: 100 milliseconds This value shall be preserved over all resets
92..95	DWord	Reserved

Table A.22 — Power Conditions Log (part 6 of 9)

Offset	Type	Description

96..97	Word	Standby_y Power Condition Flags
		
		Bit Description
		
		15 Power Condition Supported
		        1= Standby_y power condition (see 4.9.2) is supported
		        0= Standby_y power condition is not supported
		
		14 Timer Saveable
		        1= Standby_y timer is saveable (see 7.50.19.4)
		        0= Standby_y timer is not saveable
		
		13 Timer Changeable
		        1= Standby_y timer is changeable
		        0= Standby_y timer is not changeable
		
		12 Default Timer Enabled
		        1= Default Standby_y timer is enabled
		        0= Default Standby_y timer is disabled
		
		11 Saved Timer Enabled
		        1= Saved Standby_y timer is enabled
		        0= Saved Standby_y timer is disabled
		
		10 Current Timer Enabled
		        1= Current Standby_y timer is enabled
		        0= Current Standby_y timer is disabled
		
		9:0 Reserved

98..99	Word	Reserved
100..103	DWord	Default Standby_y Timer setting The Default Standby_y Timer setting is the minimum time that the device shall wait after command completion before entering the Standby_y power condition of the PM2:Standby power management state (see 4.19.4) . A value of zero indicates that this power condition is disabled . A value of FFFF_FFFFh indicates that the time is greater than or equal to 429 496 729 500 milliseconds. Measurement Units: 100 milliseconds.
104..107	DWord	Saved Standby_y Timer setting The Saved Standby_y Timer setting is the minimum time that the device shall wait after command completion before entering the Standby_y power condition of the PM2:Standby power management state . A value of zero indicates that this power condition is disabled . A value of FFFF_FFFFh indicates that the time is greater than or equal to 429 496 729 500 milliseconds. Measurement Units: 100 milliseconds.
108..111	DWord	Current Standby_y Timer setting The Current Standby_y Timer setting is the minimum time that the device shall wait after command completion before entering the Standby_y power condition of the PM2:Standby power management state . A value of zero indicates that this power condition is disabled . A value of FFFF_FFFFh indicates that the time is greater than or equal to 429 496 729 500 milliseconds. Measurement Units: 100 milliseconds

Table A.22 — Power Conditions Log (part 7 of 9)

Offset	Type	Description
112..115	DWord	Nominal Recovery time from Standby_y to PM0:Active power management state The Nominal Recovery time from Standby_y to PM0:Active is the nominal time required to transition from Standby_y to PM0:Active power management state (see 4.9.2) . This time does not include processing time for the command that caused this transition to occur . A value of zero indicates that the nominal recovery time is not specified . A value of FFFF_FFFFh indicates that the recovery time is greater than or equal to 429 496 729 500 milliseconds. Measurement Units: 100 milliseconds. This value shall be preserved over all resets.
116..119	DWord	Minimum Standby_y timer setting The Minimum Standby_y timer setting is the minimum timer value allowed by the Set Power Condition Timer subcommand (see 7.50.19.4) for the Standby_y timer . A value of zero indicates that the minimum timer value is not specified . A value of FFFF_FFFFh indicates that the minimum timer value is greater than or equal to 429 496 729 500 milliseconds. Measurement Units: 100 milliseconds This value shall be preserved over all resets
120..123	DWord	Maximum Standby_y timer setting The Maximum Standby_y timer setting is the maximum timer value allowed by the Set Power Condition Timer subcommand for the Standby_y timer . A value of zero indicates that the maximum timer value is not specified . A value of FFFF_FFFFh indicates that the maximum timer value is greater than or equal to 429 496 729 500 milliseconds. Measurement Units: 100 milliseconds This value shall be preserved over all resets
124..127	DWord	Reserved

128..129	Word	Standby_z Power Condition Flags
		
		Bit Description
		
		15 Power Condition Supported
		    Power condition supported shall be set to one to indicate that the Standby_z power condition (see 4.9.2) is supported
		
		14 Timer Saveable
		    1= Standby_z timer is saveable (see 7.50.19.4)
		    0= Standby_z timer is not saveable
		
		13 Timer Changeable
		    Shall be set to one to indicate that the Standby_z timer is changeable
		
		12 Default Timer Enabled
		    1= Default Standby_z timer is enabled
		    0= Default Standby_z timer is disabled
		
		11 Saved Timer Enabled
		    1= Saved Standby_z timer is enabled
		    0= Saved Standby_z timer is disabled
		
		10 Current Timer Enabled
		    1= Current Standby_z timer is enabled
		    0= Current Standby_z timer is disabled
		
		9:0 Reserved

130..131	Word	Reserved

Table A.22 — Power Conditions Log (part 8 of 9)

Offset	Type	Description
132..135	DWord	Default Standby_z Timer setting The Default Standby_z Timer setting is the minimum time that the device shall wait after command completion before entering the Standby_z power condition of the PM2:Standby power management state . A value of zero indicates that this power condition is disabled . A value of FFFF_FFFFh indicates that the time is greater than or equal to 429 496 729 500 milliseconds. Measurement Units: 100 milliseconds.
136..139	DWord	Saved Standby_z Timer setting The Saved Standby_z Timer setting is the minimum time that the device shall wait after command completion before entering the Standby_z power condition of the PM2:Standby power management state (see 4.19.4) . A value of zero indicates that this power condition is disabled . A value of FFFF_FFFFh indicates that the time is greater than or equal to 429 496 729 500 milliseconds. Measurement Units: 100 milliseconds.
140..143	DWord	Current Standby_z Timer setting The Current Standby_z Timer setting is the minimum time that the device shall wait after command completion before entering the Standby_z power condition of the PM2:Standby power management state . A value of zero indicates that this power condition is disabled . A value of FFFF_FFFFh indicates that the time is greater than or equal to 429 496 729 500 milliseconds. Measurement Units: 100 milliseconds
144..147	DWord	Nominal Recovery time from Standby_z to PM0:Active power management state The Nominal Recovery time from Standby_z to PM0:Active is the nominal time required to transition from Standby_z to PM0:Active power management state (see 4.9.2) . This time does not include processing time for the command that caused this transition to occur . A value of zero indicates that the nominal recovery time is not specified . A value of FFFF_FFFFh indicates that the recovery time is greater than or equal to 429 496 729 500 milliseconds. Measurement Units: 100 milliseconds. This value shall be preserved over all resets.
148..151	DWord	Minimum Standby_z timer setting The Minimum Standby_z timer setting is the minimum timer value allowed by the Set Power Condition Timer subcommand (see 7.50.19.4) for the Standby_z timer . A value of zero indicates that the minimum timer value is not specified . A value of FFFF_FFFFh indicates that the minimum timer value is greater than or equal to 429 496 729 500 milliseconds. Measurement Units: 100 milliseconds This value shall be preserved over all resets

Table A.22 — Power Conditions Log (part 9 of 9)

Offset	Type	Description
152..155	DWord	Maximum Standby_z timer setting
		The Maximum Standby_z timer setting is the maximum timer value allowed by the Set Power Condition Timer subcommand for the Standby_z timer . A value of zero indicates that the maximum timer value is not specified . A value of FFFF_FFFFh indicates that the maximum timer value is greater than or equal to 429 496 729 500 milliseconds.
		Measurement Units: 100 milliseconds
		This value shall be preserved over all resets
156..511		Reserved

A.9 Extended SMART Self-Test log (Log Address 07h)

A.9.1 Overview

Table A.23 defines the format of each of the log pages that define the Extended SMART Self-Test log . The maximum size of the self-test log is 3 449 log pages . Devices may support fewer than 3 449 log pages.

The Extended SMART Self-Test log shall support 48-bit and 28-bit addressing . All 28-bit entries contained in the SMART Self-Test log, defined in A.16 shall also be included in the Extended SMART Self-Test log with all 48-bit entries.

Table A.23 — Extended Self-test log data structure

Offset	First Log Page [b]	Subsequent Log Pages
0	Self-test log data structure revision number	Reserved
1	Reserved	Reserved
2..3	Self-test descriptor index (word)	Reserved
4..29	Descriptor entry 1	Descriptor entry $19n$ [a]+1
30..55	Descriptor entry 2	Descriptor entry $19n$ [a]+2
….	....	....
472..497	Descriptor entry 19	Descriptor entry $19n$ [a]+19
498..499	Vendor specific	Vendor specific
500..510	Reserved	Reserved
511	Data structure checksum	Data structure checksum
[a] n is the nth log page within the log.		
[b] The first log page is number zero		

The Extended Self-test log is a circular buffer . All unused self-test descriptors shall be filled with zeros.

A.9.2 Self-test descriptor index

The Self-test descriptor index indicates the most recent self-test descriptor . If there have been no self-tests, the Self-test descriptor index is set to zero.

A.9.3 Self-test log data structure revision number

The value of the self-test log data structure revision number shall be 01h.

A.9.4 Extended Self-test log descriptor entry

The content of the self-test descriptor entry is shown in Table A.24.

Table A.24 — Extended Self-test log descriptor entry

Offset	Description
n	Content of the LBA field (7:0)
n+1	Content of the self-test execution status byte
n+2..n+3	Life timestamp (word)
n+4	Content of the self-test failure checkpoint byte
n+5	Failing LBA (7:0)
n+6	Failing LBA (15:8)
n+7	Failing LBA (23:16)
n+8	Failing LBA (31:24)
n+9	Failing LBA (39:32)
n+10	Failing LBA (47:40)
n+11..n+25	Vendor specific.

Content of the LBA field (7:0) shall be the content of the LBA field (7:0) when the nth self-test subcommand was issued (see 7.55.5.2).

Content of the self-test execution status byte shall be the content of the self-test execution status byte when the nth self-test was completed (see 7.55.6.8).

Life timestamp shall contain the power-on lifetime of the device in hours when the nth self-test subcommand was completed.

Content of the self-test failure checkpoint byte may contain additional information about the self-test that failed.

The failing LBA shall be the LBA of the logical sector that caused the test to fail . If the device encountered more than one failed logical sector during the test, this field shall indicate the LBA of the first failed logical sector encountered . If the test passed or the test failed for some reason other than a failed logical sector, the value of this field is undefined.

A.9.5 Data structure checksum

The data structure checksum is the two's complement of the sum of the first 511 bytes in the data structure . Each byte shall be added with unsigned arithmetic, and overflow shall be ignored . The sum of all 512 bytes is zero when the checksum is correct . The checksum is placed in byte 511.

A.10 Host Specific logs (Log Addresses 80h-9Fh)

The mandatory Host Specific logs shall each contain sixteen log pages . The content of the Host Specific logs shall be common to all log commands (e.g., if the host places data in a Host Specific page using the SMART WRITE LOG command and issues a READ LOG EXT command to the same page, then the host receives the same data that was originally stored by SMART WRITE LOG command)

Host Specific logs may be used by the host to store any data . If a Host Specific log has never been written by the host, when read the content of the log shall be zeros.

A.11 LPS Mis-alignment log (Log Address 0Dh)

Table A.25 and table A.26 define the format of the LPS Mis-alignment log . The LPS Mis-alignment log contains the starting LBA of the first write commands for which:

   a) the first byte of data did not begin at the first byte of a physical sector; or
   b) the last byte of data did not end at the last byte of a physical sector.

If the device receives a command to read the LPS Mis-alignment log, then the device shall:

   1) return the log; and
   2) clear the number of mis-aligned logical sectors contained in this log to zero.

The LPS Mis-alignment log shall be preserved across all resets.

The LPS Mis-alignment log is not affected by Long Physical Sector Alignment Error Reporting Control (see 7.50.18).

Table A.25 — LPS Mis-alignment log (page 0)

Offset	Type	Description
0..7	QWord	Structure Version
		Bit Description
		63:32 Reserved
		31:16 Number of mis-aligned logical sectors contained in this log
		15:0 Revision number Shall be set to 0001h
8..15	QWord	Mis-aligned sector 0
		Bit Description
		63 1 = This entry has valid content, 0 = This entry shall be ignored.
		62:48 Reserved
		47:0 LBA of mis-aligned logical sector
16..23	QWord	Mis-aligned sector 1
		Bit Description
		63 1 = This entry has valid content, 0 = This entry shall be ignored.
		62:48 Reserved
		47:0 LBA of mis-aligned logical sector
		...
504..511	QWord	Mis-aligned sector 62
		Bit Description
		63 1 = This entry has valid content, 0 = This entry shall be ignored.
		62:48 Reserved
		47:0 LBA of mis-aligned logical sector

Table A.26 — LPS Mis-alignment log (pages 1..x)

Offset	Type	Description
0..7	QWord	Mis-aligned sector 63 + (((page number) - 1) * 63)
		Bit Description
		63 1 = This entry has valid content, 0 = This entry shall be ignored.
		62:48 Reserved
		47:0 LBA of mis-aligned logical sector
8..15	QWord	Mis-aligned sector 64 + (((page number) - 1) * 63)
		Bit Description
		63 1 = This entry has valid content, 0 = This entry shall be ignored.
		62:48 Reserved
		47:0 LBA of mis-aligned logical sector
		...
504..511	QWord	Mis-aligned sector 126 + (((page number) - 1) * 63)
		Bit Description
		63 1 = This entry has valid content, 0 = This entry shall be ignored.
		62:48 Reserved
		47:0 LBA of mis-aligned logical sector

A.12 NCQ Command Error log (Log Address 10h)

A.12.1 Overview

The NCQ Command Error log describes the most recent NCQ command failure, is one page in length, and is defined in table A.27 . Devices supporting the NCQ feature set (see 4.16) shall support log address 10h (i.e., NCQ Command Error).

Table A.27 — NCQ Command Error log

Offset	Description
0	**Bit Name**
	7 NQ (see A.12.3)
	6 UNL (see A.12.4)
	5 Reserved
	4:0 NCQ Tag (see A.12.2)
1	Reserved
2	Status
3	Error
4	LBA (7:0)
5	LBA (15:8)
6	LBA (23:16)
7	Device
8	LBA (31:24)
9	LBA (39:32)
10	LBA (47:40)
11	Reserved
12	Count (7:0)
13	Count (15:8)
14..255	Reserved
256..510	Vendor Specific
511	Checksum

A.12.2 NCQ Tag

If the NQ bit is cleared to zero, then the NCQ Tag field contains the NCQ Tag (see 4.16.1) corresponding to the NCQ command (see 4.16.1) that failed.

A.12.3 NQ

The NQ bit set to one indicates that the NCQ Tag field is not valid as the result of non-NCQ command having been issued . The NQ bit cleared to zero indicates that the NCQ Tag field is valid and that the error condition applies to a NCQ command.

A.12.4 Unload (UNL)

The UNL bit set to one indicates that the error condition was the result of receiving an IDLE IMMEDIATE command with the Unload Feature specified . The UNL bit cleared to zero indicates the reason for the error was not the reception of an IDLE IMMEDIATE command with the Unload Feature specified . If the last command

received was an Unload Immediate command, then the device shall not load the heads when reading the NCQ Command Error log.

If UNL is set to one, the NQ bit shall also be set to one to indicate the failure was due to reception of a non-NCQ command . If the UNL bit is set to one, then the value of the Status field, Error field, and LBA Low field (i.e., bytes 3..5) in the log page shall be set as follows:

Status: The Busy (see ATA8-APT) bit shall be cleared to zero and the Error bit (see 6.2.9) shall be set to one

Error: The Abort bit (see 6.3.2) shall be set to one

LBA [7:0]: Shall be set to C4h if the unload is being executed or has completed successfully .

            Shall be set to 4Ch if the unload was not accepted or has failed.

A.12.5 Return Fields

The Status field, Error field, LBA field and Count field indicate the error that caused the device to stop processing NCQ commands.

> NOTE 27 — The value returned in the Error field of the NCQ Command Error log may be different than the value returned in the Error field of the command Error Output structure when the initial error condition is indicated . The Error field in command Error Output structure is used for the purpose of signaling an error for an NCQ command, while the value in the Error field of the NCQ Command Error log provides specific information about the error condition.

A.12.6 Checksum

The data structure checksum is the two's complement of the sum of the first 511 bytes in the data structure . Each byte shall be added with 8-bit unsigned arithmetic and overflow shall be ignored . The sum of all 512 bytes of the data structure shall be zero.

A.13 Read Stream Error log (Log Address 22h)

Table A.28 defines the format of the Read Stream Error log . Entries are placed into the Read Stream Error log only when the Stream Error bit is set to one in the Status field . The 512 bytes returned shall contain a maximum of 31 error entries.

The Read Stream Error Count shall contain the total number of Read Stream Errors detected since the last successful read of the Read Stream Error log . This error count may be greater than 31, but only the most recent 31 errors are represented by entries in the log . If the Read Stream Error Count reaches its maximum value, after the next error is detected the Read Stream Error Count shall remain at the maximum value.

During processing of a READ LOG EXT command with the LBA field (7:0) set to 22h, a device shall clear the:

   a) Read Stream Error Log:
   b) Error Log Index to zero; and
   c) Read Stream Error Count to zero.

When the Error Log Index is zero there are no error log entries . A device shall clear the content of the Read Stream Error log during processing of a power-on reset . For a PATA device, the log is also cleared when

processing a hardware reset . For a SATA device, the Read Stream Error log is cleared on a hardware reset if Software Settings Preservation is disabled (see 7.50.16.7), otherwise it is preserved.

Table A.28 — Read Stream Error log

Offset	Description
0	Structure Version
1	Error Log Index
2..3	Read Stream Error log Count (word)
4..15	Reserved
16..31	Read Stream Error log Entry #1
32..47	Read Stream Error log Entry #2
48..63	Read Stream Error log Entry #3
64..511	Read Stream Error log Entries #4 through #31

The Data Structure Version field shall contain a value of 02h indicating the second revision of the structure format.

The Read Stream Error log Count field shall contain the number of uncorrected logical sector entries reportable to the host . This value may exceed 31.

The Error Log Index indicates the error log data structure representing the most recent error . Only values one through 31 are valid .

Table A.29 defines the format of each entry in the Read Stream Error log.

Table A.29 — Stream Error Log Entry

Offset	Description
0	Feature (7:0)
1	Feature (15:8)
2	Status
3	Error
4	LBA (7:0)
5	LBA (15:8)
6	LBA (23:16)
7	LBA (31:24)
8	LBA (39:32)
9	LBA (47:40)
10..11	Reserved
12	Count (7:0)
13	Count (15:8)
14	Reserved
15	Reserved

Byte 0..1 contains the contents of the Feature field when the error occurred . In the Write Stream Error log (see A.18), this value shall be set to FFFFh for a deferred write error.

Byte 2 contains the contents of the Status field when the error occurred.

Byte 3 contains the contents of the Error field when the error occurred.

Bytes 4..9 indicate the starting LBA of the error.

Bytes 12..13 contain the contents of the Count field indicating the length of the error . Each entry may describe a range of logical sectors starting at the given LBA and spanning the specified number of logical sectors.

A.14 SATA Phy Event Counters log (Log Address 11h)

A.14.1 Overview

The SATA Phy Event Counters log is one log page in length . The first Dword of the log page contains information that applies to the rest of the log page . The application client should continue to process counters until a counter identifier with value 0h is found or the entire page has been read . A counter identifier with value 0h indicates that the log page contains no more counter values past that point . The SATA Phy Event Counters log is defined in table A.30.

Table A.30 — SATA Phy Event Counters log Format

Offset	Description
0..3	Reserved
4..5	Counter 0 Identifier (word)
6..Counter 0 Length+5	Counter 0 Value
...	....
n..n+1	Counter x Identifier (word)
n+2..Counter x Length+n+1	Counter x Value
...	...
508..510	Reserved
511	Checksum

If the device receives a BIST Activate FIS, then the device shall reset all SATA Phy event counters to their reset value (see SATA 2.6).

If the SATA Phy Event Counters log is read and bit 0 in the Feature field is set to one, then the device shall return the current counter values for the command and then reset all Phy event counter values.

A.14.2 Counter x Identifier

SATA Phy event counter identifier that corresponds to Counter n Value . Specifies the particular event counter that is being reported . Valid identifiers are listed in SATA 2.6.

A.14.3 Counter x Value

Value of the SATA Phy event counter that corresponds to Counter x Identifier . The number of significant bits is determined by Counter x Identifier bits (14:12), see SATA 2.6 for more information . The length of Counter x Value shall always be a multiple of 16-bits . All counters are one-extended (e.g., if a counter is only physically implemented as 8-bits when it reaches the maximum value of FFh, it shall be one-extended to FFFFh) . The counter shall stop (i.e., not wrap to zero) after reaching its maximum value.

A.14.4 Counter x Length

Size of the SATA Phy event counter as defined by bits (14:12) of Counter n Identifier . The size of the SATA Phy event counter shall be a multiple of 16-bits.

A.14.5 Checksum

The data structure checksum is the two's complement of the sum of the first 511 bytes in the data structure . Each byte shall be added with unsigned arithmetic and overflow shall be ignored . The sum of all 512 bytes of the data structure is zero when the checksum is correct.

A.15 Selective Self-Test log (Log Address 09h)

A.15.1 Overview

The Selective Self-Test log may be both written and read by the host . The Selective Self-Test log allows the host to select the parameters for the self-test and to monitor the progress of the self-test . Table A.31 defines the content of the Selective Self-Test log.

Table A.31 — Selective Self-Test log

Offset	Type	Description	Read/Write
0..1	Word	Data structure revision number	R/W
2..9	Qword	Starting LBA for test span 1	R/W
10..17	Qword	Ending LBA for test span 1	R/W
18..25	Qword	Starting LBA for test span 2	R/W
26..33	Qword	Ending LBA for test span 2	R/W
34..41	Qword	Starting LBA for test span 3	R/W
42..49	Qword	Ending LBA for test span 3	R/W
50..57	Qword	Starting LBA for test span 4	R/W
58..65	Qword	Ending LBA for test span 4	R/W
66..73	Qword	Starting LBA for test span 5	R/W
74..81	Qword	Ending LBA for test span 5	R/W
82..337		Reserved	Reserved
338..491		Vendor specific	Vendor specific
492..499	Qword	Current LBA under test	Read [a]
500..501	Word	Current span under test	Read [a]
502..503	Word	Feature flags	R/W
504..507		Vendor specific	Vendor specific
508..509	Word	Selective self-test pending time	R/W
510		Reserved	Reserved
511		Data structure checksum	R/W
[a] Fields marked Read shall be ignored by the device when the host writes them.			

A.15.2 Data structure revision number

The value of the data structure revision number shall be 01h . This value shall be written by the host and returned unmodified by the device.

A.15.3 Test span definition

The Selective Self-Test log provides for the definition of up to five test spans . The starting LBA for each test span is the LBA of the first logical sector tested in the test span and the ending LBA for each test span is the LBA

of the last logical sector tested in the test span . If the starting LBA and ending LBA values for a test span are both zero, then a test span is not defined and not tested . The Starting LBA and Ending LBA for each test span are written by the host and shall be returned unmodified by the device.

A.15.4 Current LBA under test

The device shall modify this value to contain the LBA of the logical sector currently under test at least once every 65 536 logical sectors tested . When the self-test including the off-line scan between test spans has been completed, a zero value shall be placed in this field.

A.15.5 Current span under test

As the self-test progresses, the device shall modify this value to contain the test span number of the current span being tested . If an off-line scan between test spans is selected, then a value greater than five is placed in this field during the off-line scan . When the self-test including the off-line scan between test spans has been completed, a zero value shall be placed in this field.

A.15.6 Feature flags

The Feature flags define the features of Selective self-test to be processed (see table A.32).

Table A.32 — Selective self-test feature flags

Bit	Description
5..15	Reserved.
4	When set to one, off-line scan after selective test is active.
3	When set to one, off-line scan after selective test is pending.
2	Vendor specific
1	When set to one, perform off-line scan after selective test.
0	Vendor specific

Feature flag bit (1) shall be written by the host and returned unmodified by the device . Feature flag bits (4:3) shall be cleared to zero by the host and the device shall modify them as the test progresses.

A.15.7 Selective self-test pending time

The selective self-test pending time is the time in minutes from power-on to the resumption of the off-line testing if the pending bit is set to one . At the expiration of this time, the device sets the active bit (i.e.,Selective self-test feature flags bit 4) to one, and resumes the off-line scan that had begun before power-down.

A.15.8 Data structure checksum

The data structure checksum is defined in A.17.6.

A.16 SMART Self-Test log (Log Address 06h)

A.16.1 Overview

Table A.33 defines the content of the SMART Self-Test log . The SMART Self-Test log supports 28-bit addressing only.

Table A.33 — Self-test log data structure

Offset	Description
0..1	Self-test log data structure revision number
2..25	First descriptor entry
26..49	Second descriptor entry
.....	....
482..505	Twenty-first descriptor entry
506..507	Vendor specific
508	Self-test index
509..510	Reserved
511	Data structure checksum

The SMART Self-Test log is a circular buffer . If fewer than 21 self-tests have been performed by the device, the unused descriptor entries shall be filled with zeroes.

A.16.2 Self-test log data structure revision number

The value of the self-test log data structure revision number shall be 0001h.

A.16.3 Self-test log descriptor entry

The content of the self-test descriptor entry is shown in table A.34.

Table A.34 — Self-test log descriptor entry

Offset	Description
n	Content of the LBA field (7:0)
n+1	Content of the self-test execution status byte
n+2..n+3	Life timestamp (word)
n+4	Content of the self-test failure checkpoint byte
n+5	Failing LBA (7:0)
n+6	Failing LBA (15:8)
n+7	Failing LBA (23:16)
n+8	Failing LBA (27:24)
n+9..n+23	Vendor specific

Content of the LBA field (7:0) shall be the content of the LBA field (7:0) when the nth self-test subcommand was issued (see 7.55.5.2).

Content of the self-test execution status byte shall be the content of the self-test execution status byte when the nth self-test was completed (see 7.55.6.8).

Life timestamp shall contain the power-on lifetime of the device in hours when the nth self-test subcommand was completed.

Content of the self-test failure checkpoint byte may contain additional information about the self-test that failed.

The failing LBA shall be the LBA of the uncorrectable logical sector that caused the test to fail . If the device encountered more than one uncorrectable logical sector during the test, this field shall indicate the LBA of the first uncorrectable logical sector encountered . If the test passed or the test failed for some reason other than an uncorrectable logical sector, the value of this field is undefined.

A.16.4 Self-test index

The self-test index shall point to the most recent entry . If the log is empty, then the index shall be set to zero . It shall be set to one when the first entry is made, two for the second entry, etc., until the 22nd entry, when the index shall be reset to one.

A.16.5 Data structure checksum

The data structure checksum is the two's complement of the sum of the first 511 bytes in the data structure . Each byte shall be added with unsigned arithmetic, and overflow shall be ignored . The sum of all 512 bytes is zero when the checksum is correct . The checksum is placed in byte 511.

A.17 Summary SMART Error log (Log Address 01h)

A.17.1 Overview

Table A.35 defines the log page that makes up the SMART summary error log . Summary SMART Error log data structures shall include, but are not limited to, Uncorrectable errors, ID Not Found errors for which the LBA requested was valid, servo errors, write fault errors . Summary error log data structures shall not include errors attributed to the receipt of faulty commands (e.g., command codes not implemented by the device or requests with invalid parameters or invalid LBAs) . If the device supports the Comprehensive SMART Error log (see A.4), then the Summary SMART Error log duplicates the last five error entries in the Comprehensive SMART Error log . The Summary SMART Error log supports 28-bit addressing only.

Table A.35 — Summary SMART Error log

Offset	Description
0	SMART error log version
1	Error log index
2..91	First error log data structure
92..181	Second error log data structure
182..271	Third error log data structure
272..361	Fourth error log data structure
362..451	Fifth error log data structure
452..453	Device error count (word)
454..510	Reserved
511	Data structure checksum

A.17.2 Error log version

The value of the Summary SMART Error log version byte shall be 01h.

A.17.3 Error log index

The error log index indicates the error log data structure representing the most recent error . Only values zero through five are valid . If there are no error log entries, the value of the error log index shall be zero.

A.17.4 Error log data structure

A.17.4.1 Overview

An Error log data structure shall contain the last five errors reported by the device . These Error log data structure entries are a circular buffer . The Error log index indicates the most recent error log structure . If fewer than five errors have occurred, the unused Error log structure entries shall be zero filled . Table A.36 describes the content of a valid Error log data structure.

Table A.36 — Error log data structure

Offset	Description
n - n+11	First command data structure
n+12 - n+23	Second command data structure
n+24 - n+35	Third command data structure
n+36 - n+47	Fourth command data structure
n+48 - n+59	Fifth command data structure
n+60 - n+89	Error data structure

A.17.4.2 Command data structure

The Error log data structures contain the following:

a)   the fifth command data structure shall contain the command or reset for which the error is being reported;
b)   the fourth command data structure should contain the command or reset that preceded the command or reset for which the error is being reported;
c)   the third command data structure should contain the command or reset preceding the one in the fourth command data structure;
d)   the second command data structure should contain the command or reset preceding the one in the third command data structure; and
e)   the first command data structure should contain the command or reset preceding the one in the second command data structure.

If fewer than four commands and resets preceded the command or reset for which the error is being reported, the unused command data structures shall be zero filled (e.g., if only three commands and resets preceded the command or reset for which the error is being reported, the first command data structure shall be zero filled) . In some devices, the hardware implementation may preclude the device from reporting the commands that preceded the command for which the error is being reported or that preceded a reset . In this case, the command data structures are zero filled .

If the command data structure represents a command or software reset, the content of the command data structure shall be as shown in table A.37 . If the command data structure represents a hardware reset, the

content of byte n shall be FFh, the content of bytes n+1 through n+7 are vendor specific, and the content of bytes n+8 through n+11 shall contain the timestamp.

Table A.37 — Command data structure

Offset	Description
n	Transport specific value when the Command was initiated . See the appropriate transport standard, reference Device Control field.
n+1	Content of the Feature (7:0) when the Command was initiated
n+2	Content of the Count (7:0) when the Command was initiated
n+3	Content of the LBA field (7:0) when the Command was initiated
n+4	Content of the LBA field (15:8) when the Command was initiated
n+5	Content of the LBA field (23:16) when the Command was initiated
n+6	Content of the Device field when the Command was initiated
n+7	Content written when the Command was initiated
n+8..n+11	Timestamp (DWord)

Timestamp shall be the time since power-on in milliseconds when command acceptance occurred . This timestamp may wrap around.

A.17.4.3 Error data structure

The error data structure shall contain the error description of the command for which an error was reported as described in table A.37 . If the error was logged for a hardware reset, the content of bytes n+1 through n+7 shall be vendor specific and the remaining bytes shall be as defined in table A.38.

Table A.38 — Error data structure

Offset	Description
n	Reserved
n+1	Content of the Error (7:0) after command completion occurred
n+2	Content of the Count (7:0) after command completion occurred
n+3	Content of the LBA field (7:0) after command completion occurred
n+4	Content of the LBA field (15:8) after command completion occurred
n+5	Content of the LBA field (23:16) after command completion occurred
n+6	Content of the Device field after command completion occurred
n+7	Content written to the Status field after command completion occurred
n+8..n+26	Extended error information
n+27	State
n+28..n+29	Life timestamp (word)

Extended error information shall be vendor specific.

The State field shall contain a value indicating the state of the device when the command was initiated or the reset occurred as described in table A.39.

Table A.39 — State field values

Value	State
x0h	Unknown
x1h	Sleep
x2h	Standby
x3h	Active/Idle
x4h	Executing SMART off-line or self-test
x5h-xAh	Reserved
xBh-xFh	Vendor specific
The value of x is vendor specific and may be different for each state.	

Sleep indicates the reset for which the error being reported was received when the device was in the Sleep mode (see 4.19.4).

Standby indicates the command or reset for which the error being reported was received when the device was in the Standby mode (see 4.19.4).

Active/Idle indicates the command or reset for which the error being reported was received when the device was in the Active mode or Idle mode (see 4.19.4).

Processing SMART off-line or SMART self-test indicates the command or reset for which the error being reported was received when the device was processing a SMART off-line (see 7.55.5.2.4) or SMART self-test (see 7.55.5.2.1).

The Life timestamp field shall contain the power-on lifetime of the device in hours when command completion occurred.

A.17.5 Device error count

The Device Error Count field shall contain the total number of errors attributable to the device that have been reported by the device during the life of the device (e.g., these errors shall include Uncorrectable errors, ID Not Found errors for which the LBA requested was valid, servo errors, write fault errors) . The device error count shall not include errors attributed to the receipt of faulty commands (e.g., command codes not implemented by the device or requests with invalid parameters or invalid LBAs) . If the maximum value for this field is reached, the count shall remain at the maximum value when additional errors are encountered and logged.

A.17.6 Data structure checksum

The data structure checksum is the two's complement of the sum of the first 511 bytes in the data structure . Each byte shall be added with unsigned arithmetic, and overflow shall be ignored . The sum of all 512 bytes shall be zero when the checksum is correct . The checksum is placed in byte 511.

A.18 Write Stream Error log (Log Address 21h)

Table A.40 defines the format of the Write Stream Error log . Entries are placed into the Write Stream Error log only when the Stream Error bit is set to one in the Status field . The log page shall contain a maximum of 31 error entries.

The Write Stream Error Count shall contain the total number of Write Stream Errors detected since the last successful reading of the Write Stream Error log . This error count may be greater than 31, but only the most

recent 31 errors are represented by entries in the log . If the Write Stream Error Count reaches its maximum value, then after the next error is detected the Write Stream Error Count shall remain at the maximum value.

When the Write Stream Error log has been read by the host, the device shall clear the:

   a)   Write Stream Error Log;
   b)   Error Log Index to zero; and
   c)   Write Stream Error Count to zero.

If the Error Log Index is zero, then there are no entries in the Write Stream Error log . A device shall clear the content of the Write Stream Error log during processing of a power-on reset . For a PATA device, the log is also cleared when processing a hardware reset . For a SATA device, the log is cleared on a hardware reset if Software Settings Preservation is disabled (see 7.50.16.7), otherwise it is preserved.

Table A.40 — Write Stream Error log

Offset	Description
0	Structure Version
1	Error Log Index
2..3	Write Stream Error log Count (word)
4..15	Reserved
16..31	Write Stream Error log Entry #1
32..47	Write Stream Error log Entry #2
48..63	Write Stream Error log Entry #3
64..511	Write Stream Error log Entries #4 through #31

The Data Structure Version field shall contain a value of 02h indicating the second revision of the structure format.

The Write Stream Error log Count field shall contain the number of WRITE STREAM EXT command (see 7.77) entries since the last power-on reset, hardware reset, or since this log was last read.

The Error Log Index indicates the error log data structure representing the most recent error . Only values one through 31 are valid.

Table A.29 defines the format of each Write Stream Error log Entry.

Annex B
(Informative)

Command Set summary

Table B.1 provides information on which command codes are currently defined . Table B.2 provides a list of all of the commands in order of command code with the required use for each . Table B.3 provides a summary of all commands in alphabetical order with the required use for each . Table B.4 provides the assignment history of each opcode by ATA standard . Table B.5 provides the assignment history of each SET FEATURES code by ATA standard.

Table B.1 — Command Matrix

	x0h	x1h	x2h	x3h	x4h	x5h	x6h	x7h	x8h	x9h	xAh	xBh	xCh	xDh	xEh	xFh
0xh	C	R	R	C	R	R	C*	R	C	R	R	C*	R	R	R	R
1xh	O	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
2xh	C	O	O	O	C	C	O*	C	R	C	C	C	R	R	R	C
3xh	C	O	O	O	C	C	O*	C	C	C	C	C	O	C	O*	C
4xh	C	O	C	R	R	C	R	C	R	R	R	R	R	R	R	R
5xh	O	C	R	R	R	R	R	C	R	R	R	C	C	C	C	C
6xh	C	C	S	S	S	S	S	S	R	R	R	R	R	R	R	R
7xh	O	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
8xh	V	V	V	V	V	V	V	F	V	V	V	V	V	V	V	V
9xh	C	O	C	C*	E	E	E	E	E	E	V	R	R	R	R	R
Axh	C	C	O*	R	R	R	R	R	R	R	R	R	R	R	R	R
Bxh	C	C	R	R	C*	R	C	R	A	A	A	R	R	R	R	R
Cxh	F	V	V	V	C	C	C	O*	C	O	C	O	O*	C	C	R
Dxh	R	C	M	M	M	R	R	R	R	R	O	E	E	E	O	O
Exh	C	C	C	C	C	C	C	C	C	C*	C	C*	C	O	O	C
Fxh	V	C	C	C	C	C	C	V	C	C	V	V	V	V	V	V

Key:	
C = defined command.	M = Reserved for the Media Card Pass Through Command feature set.
R = Reserved, undefined in current specifications.	S = Reserved for Serial ATA
V = Vendor specific commands .	* indicates that the entry in this table has changed from ATA8-ACS.
O = Obsolete.	
E = retired command.	
F= If the device does not implement the CFA feature set (see 4.7), this command code is Vendor specific .	
A= Reserved for assignment by the CompactFlash Association	

Table B.2 — Command codes (sorted by command code) (part 1 of 4)

Command	Command Code	ATA device	ATAPI device	Protocol	Argument
NOP	00h	O	M	ND	28-bit
Reserved	01h..02h				
CFA REQUEST EXTENDED ERROR	03h	O	N	ND	28-bit
Reserved	04h..05h				
DATA SET MANAGEMENT	06h	O	P	DM	48-bit
Reserved	07h				
DEVICE RESET	08h	N	M	DR	28-bit
Reserved	09h..0Ah				
REQUEST SENSE DATA EXT	0Bh	O	P	ND	48-bit
Reserved	0Ch..0Fh				
Obsolete	10h				
Retired	11h..1Fh				
READ SECTOR(S)	20h	O	M	PI	28-bit
Obsolete	21h..23h				
READ SECTOR(S) EXT	24h	O	N	PI	48-bit
READ DMA EXT	25h	O	N	DM	48-bit
Obsolete	26h				
READ NATIVE MAX ADDRESS EXT	27h	O	N	ND	48-bit
Reserved	28h				
READ MULTIPLE EXT	29h	O	N	PI	48-bit
READ STREAM DMA EXT	2Ah	O	N	DM	48-bit
READ STREAM EXT	2Bh	O	N	PI	48-bit
Reserved	2Ch..2Fh				
READ LOG EXT	2Fh	O	O	PI	48-bit
WRITE SECTOR(S)	30h	O	N	PO	28-bit
Obsolete	31h..33h				
WRITE SECTOR(S) EXT	34h	O	N	PO	48-bit
WRITE DMA EXT	35h	O	N	DM	48-bit
Obsolete	36h				
SET MAX ADDRESS EXT	37h	O	N	ND	48-bit
CFA WRITE SECTORS WITHOUT ERASE	38h	O	N	PO	28-bit
WRITE MULTIPLE EXT	39h	O	N	PO	48-bit
WRITE STREAM DMA EXT	3Ah	O	N	DM	48-bit
WRITE STREAM EXT	3Bh	O	N	PO	48-bit

Key:

    ND = Non-Data command

    PI = PIO Data-In command

    PO = PIO Data-Out command

    DM = DMA command

    DMQ = DMA QUEUED command

    DR = DEVICE RESET command

    DD = EXECUTE DEVICE
        DIAGNOSTIC command

    P = PACKET command

    VS = Vendor specific

M = Mandatory

O = Optional

N = Use prohibited

V = Vendor specific implementation

E = Retired

B = Obsolete

R = Reserved

F = If the device does not implement the CFA feature set (see 4.7), this command code is Vendor specific.

Table B.2 — Command codes (sorted by command code) (part 2 of 4)

Command	Command Code	ATA device	ATAPI device	Protocol	Argument
Obsolete	3Ch				
WRITE DMA FUA EXT	3Dh	O	N	DM	48-bit
Obsolete	3Eh				
WRITE LOG EXT	3Fh	O	O	PO	48-bit
READ VERIFY SECTOR(S)	40h	O	N	ND	28-bit
Obsolete	41h				
READ VERIFY SECTOR(S) EXT	42h	O	N	ND	48-bit
Reserved	43h..44h				
WRITE UNCORRECTABLE EXT	45h	O	N	ND	48-bit
Reserved	46h				
READ LOG DMA EXT	47h	O	O	DM	48-bit
Reserved	48h..4Fh				
Obsolete	50h				
CONFIGURE STREAM	51h	O	O	ND	48-bit
Reserved	52h..56h				
WRITE LOG DMA EXT	57h	O	O	DM	48-bit
Reserved	58h..5Ah				
TRUSTED NON-DATA	5Bh	O	P	ND	28-bit
TRUSTED RECEIVE	5Ch	O	P	PI	28-bit
TRUSTED RECEIVE DMA	5Dh	O	P	DM	28-bit
TRUSTED SEND	5Eh	O	P	PO	28-bit
TRUSTED SEND DMA	5Fh	O	P	DM	28-bit
READ FPDMA QUEUED	60h	O	N	DMQ	48-bit
WRITE FPDMA QUEUED	61h	O	N	DMQ	48-bit
Reserved	62h..6Fh				
Obsolete	70h				
Retired	71h..7Fh				
Vendor Specific	80h..86h			VS	
CFA TRANSLATE SECTOR	87h	O	N	PI	28-bit
Vendor Specific	88h..8Fh			VS	
EXECUTE DEVICE DIAGNOSTIC	90h	M	M	DD	28-bit
Obsolete	91h				
DOWNLOAD MICROCODE	92h	O	N	PO	28-bit
DOWNLOAD MICROCODE DMA	93h	O	N	DM	28-bit
Retired	94h..99h				

Key:

ND = Non-Data command
PI = PIO Data-In command
PO = PIO Data-Out command
DM = DMA command
DMQ = DMA QUEUED command
DR = DEVICE RESET command
DD = EXECUTE DEVICE
    DIAGNOSTIC command
P = PACKET command
VS = Vendor specific

M = Mandatory
O = Optional
N = Use prohibited
V = Vendor specific implementation
E = Retired
B = Obsolete
R = Reserved
F = If the device does not implement the CFA feature set
(see 4.7), this command code is Vendor specific.

Table B.2 — Command codes (sorted by command code) (part 3 of 4)

Command	Command Code	ATA device	ATAPI device	Protocol	Argument
Vendor Specific	9Ah				
Reserved	9Bh..9Fh				
PACKET	A0h	N	M	P	
IDENTIFY PACKET DEVICE	A1h	N	M	PI	28-bit
Obsolete	A2h	O	O	P/DMQ	
Reserved	A3h..AFh				
SMART	B0h	O	N	ND	
Device Configuration Overlay	B1h	O	O	ND	28-bit
Reserved	B2h..B3h				
Sanitize Device	B4h	O	N	ND	48-bit
Reserved	B5h				
NV Cache	B6h	O	N	DM/ND	48-bit
Reserved for the CompactFlash Association	B7h..BBh				
Reserved	BCh..BFh				
CFA ERASE SECTORS	C0h	F	N	ND	28-bit
Vendor Specific	C1h..C3h			VS	
READ MULTIPLE	C4h	O	N	PI	28-bit
WRITE MULTIPLE	C5h	O	N	PO	28-bit
SET MULTIPLE MODE	C6h	O	N	ND	28-bit
Obsolete	C7h				
READ DMA	C8h	O	N	DM	28-bit
Obsolete	C9h				
WRITE DMA	CAh	O	N	DM	28-bit
Obsolete	CBh				
Obsolete	CCh				
CFA WRITE MULTIPLE WITHOUT ERASE	CDh	O	N	PO	28-bit
WRITE MULTIPLE FUA EXT	CEh	O	N	PO	48-bit
Reserved	CFh				
Reserved	D0h				
CHECK MEDIA CARD TYPE	D1h	O	N	ND	28-bit
Reserved for the Media Card Pass Through Command feature set	D2h				
Reserved for the Media Card Pass Through Command feature set	D3h				
Reserved for the Media Card Pass Through Command feature set	D4h				
Key: 　　　ND = Non-Data command 　　　PI = PIO Data-In command 　　　PO = PIO Data-Out command 　　　DM = DMA command 　　　DMQ = DMA QUEUED command 　　　DR = DEVICE RESET command 　　　DD = EXECUTE DEVICE 　　　　　 DIAGNOSTIC command 　　　P = PACKET command 　　　VS = Vendor specific		M = Mandatory O = Optional N = Use prohibited V = Vendor specific implementation E = Retired B = Obsolete R = Reserved F = If the device does not implement the CFA feature set (see 4.7), this command code is Vendor specific.			

Table B.2 — Command codes (sorted by command code) (part 4 of 4)

Command	Command Code	ATA device	ATAPI device	Protocol	Argument
Reserved	D5h..D9h				
Obsolete	DAh				
Retired	DBh..DDh				
Obsolete	DEh				
Obsolete	DFh				
STANDBY IMMEDIATE	E0h	M	M	ND	28-bit
IDLE IMMEDIATE	E1h	M	M	ND	28-bit
STANDBY	E2h	M	O	ND	28-bit
IDLE	E3h	M	O	ND	28-bit
READ BUFFER	E4h	O	N	PI	28-bit
CHECK POWER MODE	E5h	M	M	ND	28-bit
SLEEP	E6h	M	M	ND	28-bit
FLUSH CACHE	E7h	O	O	ND	28-bit
WRITE BUFFER	E8h	O	N	PO	28-bit
READ BUFFER DMA	E9h	O	N	DM	28-bit
FLUSH CACHE EXT	EAh	O	N	ND	28-bit
WRITE BUFFER DMA	EBh	O	N	DM	28-bit
IDENTIFY DEVICE	ECh	M	M	PI	28-bit
Obsolete	EDh				
Obsolete	EEh				
SET FEATURES	EFh	M	M	ND	28-bit
Vendor Specific	F0h			VS	
SECURITY SET PASSWORD	F1h	O	O	PO	28-bit
SECURITY UNLOCK	F2h	O	O	PO	28-bit
SECURITY ERASE PREPARE	F3h	O	O	ND	28-bit
SECURITY ERASE UNIT	F4h	O	O	PO	28-bit
SECURITY FREEZE LOCK	F5h	O	O	ND	28-bit
SECURITY DISABLE PASSWORD	F6h	O	O	PO	28-bit
Vendor Specific	F7h				
READ NATIVE MAX ADDRESS	F8h	O	O	ND	28-bit
SET MAX ADDRESS	F9h	O	O	ND	28-bit
Vendor Specific	FAh..FFh			VS	
Key:　　ND = Non-Data command　　　　　M = Mandatory 　　　　PI = PIO Data-In command　　　　O = Optional 　　　　PO = PIO Data-Out command　　　N = Use prohibited 　　　　DM = DMA command　　　　　　　V = Vendor specific implementation 　　　　DMQ = DMA QUEUED command　　E = Retired 　　　　DR = DEVICE RESET command　　　B = Obsolete 　　　　DD = EXECUTE DEVICE　　　　　　R = Reserved 　　　　　　DIAGNOSTIC command　　　F = If the device does not implement the CFA feature set 　　　　P = PACKET command　　　　　　(see 4.7), this command code is Vendor specific. 　　　　VS = Vendor specific					

Table B.3 — Command codes (sorted by command name) (part 1 of 3)

Command	Command Code	ATA device	ATAPI device	Protocol	Argument
CFA ERASE SECTORS	C0h	F	N	ND	28-bit
CFA REQUEST EXTENDED ERROR	03h	O	N	ND	28-bit
CFA TRANSLATE SECTOR	87h	O	N	PI	28-bit
CFA WRITE MULTIPLE WITHOUT ERASE	CDh	O	N	PO	28-bit
CFA WRITE SECTORS WITHOUT ERASE	38h	O	N	PO	28-bit
CHECK MEDIA CARD TYPE	D1h	O	N	ND	28-bit
CHECK POWER MODE	E5h	M	M	ND	28-bit
CONFIGURE STREAM	51h	O	O	ND	48-bit
DATA SET MANAGEMENT	06h	O	P	DM	48-Bit
Device Configuration Overlay	B1h	O	O	ND/PI/PO/DM	28-bit
DEVICE RESET	08h	N	M	DR	28-bit
DOWNLOAD MICROCODE	92h	O	N	PO	28-bit
DOWNLOAD MICROCODE DMA	93h	O	N	DM	28-bit
EXECUTE DEVICE DIAGNOSTIC	90h	M	M	DD	28-bit
FLUSH CACHE	E7h	O	O	ND	28-bit
FLUSH CACHE EXT	EAh	O	N	ND	28-bit
IDENTIFY DEVICE	ECh	M	M	PI	28-bit
IDENTIFY PACKET DEVICE	A1h	N	M	PI	28-bit
IDLE	E3h	M	O	ND	28-bit
IDLE IMMEDIATE	E1h	M	M	ND	28-bit
NOP	00h	O	M	ND	28-bit
NV Cache	B6h	O	N	DM/ND	48-bit
Obsolete	10h, 21h..23h, 26h, 31h..33h, 36h, 3Ch, 3Eh, 41h, 50h, 70h, 91h, A2h, C7h, C9h, CBh..CCh, DAh, DEh, DFh, EDh..EEh,				
PACKET	A0h	N	M	P	
READ BUFFER	E4h	O	N	PI	28-bit
READ BUFFER DMA	E9h	O	N	DM	28-bit
READ DMA	C8h	O	N	DM	28-bit
READ DMA EXT	25h	O	N	DM	48-bit
READ FPDMA QUEUED	60h	O	N	DMQ	48-bit
READ LOG DMA EXT	47h	O	O	DM	48-bit
READ LOG EXT	2Fh	O	O	PI	48-bit
READ MULTIPLE	C4h	O	N	PI	28-bit
READ MULTIPLE EXT	29h	O	N	PI	48-bit

Key:

- ND = Non-Data command
- PI = PIO Data-In command
- PO = PIO Data-Out command
- DM = DMA command
- DMQ = DMA QUEUED command
- DR = DEVICE RESET command
- DD = EXECUTE DEVICE
    DIAGNOSTIC command
- P = PACKET command

- M = Mandatory
- O = Optional
- N = Use prohibited
- E = Retired
- R = Reserved
- F = If the device does not implement the CFA feature set (see 4.7), this command code is Vendor specific.

Table B.3 — Command codes (sorted by command name) (part 2 of 3)

Command	Command Code	ATA device	ATAPI device	Protocol	Argument
READ NATIVE MAX ADDRESS	F8h	O	O	ND	28-bit
READ NATIVE MAX ADDRESS EXT	27h	O	N	ND	48-bit
READ SECTOR(S)	20h	O	M	PI	28-bit
READ SECTOR(S) EXT	24h	O	N	PI	48-bit
READ STREAM DMA EXT	2Ah	O	N	DM	48-bit
READ STREAM EXT	2Bh	O	N	PI	48-bit
READ VERIFY SECTOR(S)	40h	O	N	ND	28-bit
READ VERIFY SECTOR(S) EXT	42h	O	N	ND	48-bit
REQUEST SENSE DATA EXT	0Bh	O	P	ND	48-bit
Reserved	01h..02h, 04h..05h, 07h, 09h..0Ah, 0Ch..0Fh, 28h, 2Ch..2Fh, 43h..44h, 46h, 48h..4Fh, 52h..56h, 58h..5Ah, 62h..6Fh, 9Bh..9Fh, A3h..AFh, B2h..B3h, B5h, BCh..BFh, CFh, D0h, D5h..D9h				
Reserved for the CompactFlash Association	B7h..BBh				
Reserved for the Media Card Pass Through Command feature set	D2h				
Reserved for the Media Card Pass Through Command feature set	D3h				
Reserved for the Media Card Pass Through Command feature set	D4h				
Retired	11h..1Fh, 71h..7Fh, 94h..99h, DBh..DDh				
Sanitize Device	B4h	O	N	ND	48-bit
SECURITY DISABLE PASSWORD	F6h	O	O	PO	28-bit
SECURITY ERASE PREPARE	F3h	O	O	ND	28-bit
SECURITY ERASE UNIT	F4h	O	O	PO	28-bit
SECURITY FREEZE LOCK	F5h	O	O	ND	28-bit
SECURITY SET PASSWORD	F1h	O	O	PO	28-bit
SECURITY UNLOCK	F2h	O	O	PO	28-bit
SET FEATURES	EFh	M	M	ND	28-bit
SET MAX ADDRESS	F9h	O	O	ND	28-bit
SET MAX ADDRESS EXT	37h	O	N	ND	48-bit
SET MULTIPLE MODE	C6h	O	N	ND	28-bit
SLEEP	E6h	M	M	ND	28-bit
SMART	B0h	O	N	ND	
STANDBY	E2h	M	O	ND	28-bit
STANDBY IMMEDIATE	E0h	M	M	ND	28-bit
TRUSTED NON-DATA	5Bh	O	P	ND	28-bit

Key:
ND = Non-Data command
PI = PIO Data-In command
PO = PIO Data-Out command
DM = DMA command
DMQ = DMA QUEUED command
DR = DEVICE RESET command
DD = EXECUTE DEVICE
    DIAGNOSTIC command
P = PACKET command

M = Mandatory
O = Optional
N = Use prohibited
E = Retired
R = Reserved
F = If the device does not implement the CFA feature set (see 4.7), this command code is Vendor specific.

Table B.3 — Command codes (sorted by command name) (part 3 of 3)

Command	Command Code	ATA device	ATAPI device	Protocol	Argument
TRUSTED RECEIVE	5Ch	O	P	PI	28-bit
TRUSTED RECEIVE DMA	5Dh	O	P	DM	28-bit
TRUSTED SEND	5Eh	O	P	PO	28-bit
TRUSTED SEND DMA	5Fh	O	P	DM	28-bit
Vendor Specific	80h..86h, 88h..8Fh, 9Ah, C1h..C3h, F0h, F7h, FAh..FFh				
WRITE BUFFER	E8h	O	N	PO	28-bit
WRITE BUFFER DMA	EBh	O	N	DM	28-bit
WRITE DMA	CAh	O	N	DM	28-bit
WRITE DMA EXT	35h	O	N	DM	48-bit
WRITE DMA FUA EXT	3Dh	O	N	DM	48-bit
WRITE FPDMA QUEUED	61h	O	N	DMQ	48-bit
WRITE LOG DMA EXT	57h	O	O	DM	48-bit
WRITE LOG EXT	3Fh	O	O	PO	48-bit
WRITE MULTIPLE	C5h	O	N	PO	28-bit
WRITE MULTIPLE EXT	39h	O	N	PO	48-bit
WRITE MULTIPLE FUA EXT	CEh	O	N	PO	48-bit
WRITE SECTOR(S)	30h	O	N	PO	28-bit
WRITE SECTOR(S) EXT	34h	O	N	PO	48-bit
WRITE STREAM DMA EXT	3Ah	O	N	DM	48-bit
WRITE STREAM EXT	3Bh	O	N	PO	48-bit
WRITE UNCORRECTABLE EXT	45h	O	N	ND	48-bit

Key:
ND = Non-Data command
PI = PIO Data-In command
PO = PIO Data-Out command
DM = DMA command
DMQ = DMA QUEUED command
DR = DEVICE RESET command
DD = EXECUTE DEVICE
    DIAGNOSTIC command
P = PACKET command

M = Mandatory
O = Optional
N = Use prohibited
E = Retired
R = Reserved
F = If the device does not implement the CFA feature set (see 4.7), this command code is Vendor specific.

Table B.4 — Historical Command Assignments (part 1 of 9)

Opcode	Command Name	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2
00h	NOP	C	C	C	C	C	C	C	C	C
01h		R	R	R	R	R	R	R	R	R
02h		R	R	R	R	R	R	R	R	R
03h	CFA REQUEST EXTENDED ERROR	R	R	R	C	C	C	C	C	C
04h		R	R	R	R	R	R	R	R	R
05h		R	R	R	R	R	R	R	R	R
06h	DATA SET MANAGEMENT	R	R	R	R	R	R	R	R	C*
07h		R	R	R	R	R	R	R	R	R
08h	ATAPI Soft Reset / DEVICE RESET	R	R	C	C	C	C	C	C	C
09h		R	R	R	R	R	R	R	R	R
0Ah		R	R	R	R	R	R	R	R	R
0Bh	REQUEST SENSE DATA EXT	R	R	R	R	R	R	R	R	C
0Ch		R	R	R	R	R	R	R	R	R
0Dh		R	R	R	R	R	R	R	R	R
0Eh		R	R	R	R	R	R	R	R	R
0Fh		R	R	R	R	R	R	R	R	R
10h	RECALIBRATE	C	C	C	O	O	O	O	O	O
11h	RECALIBRATE	C	C	O	E	E	E	E	E	E
12h	RECALIBRATE	C	C	O	E	E	E	E	E	E
13h	RECALIBRATE	C	C	O	E	E	E	E	E	E
14h	RECALIBRATE	C	C	O	E	E	E	E	E	E
15h	RECALIBRATE	C	C	O	E	E	E	E	E	E
16h	RECALIBRATE	C	C	O	E	E	E	E	E	E
17h	RECALIBRATE	C	C	O	E	E	E	E	E	E
18h	RECALIBRATE	C	C	O	E	E	E	E	E	E
19h	RECALIBRATE	C	C	O	E	E	E	E	E	E
1Ah	RECALIBRATE	C	C	O	E	E	E	E	E	E
1Bh	RECALIBRATE	C	C	O	E	E	E	E	E	E
1Ch	RECALIBRATE	C	C	O	E	E	E	E	E	E
1Dh	RECALIBRATE	C	C	O	E	E	E	E	E	E
1Eh	RECALIBRATE	C	C	O	E	E	E	E	E	E
1Fh	RECALIBRATE	C	C	O	E	E	E	E	E	E

Key:
- C = a defined command.
- E = a retired command.
- O = Obsolete.
- R = Reserved, undefined in current specifications.
- V = Vendor specific commands.

A = Reserved for assignment by the CompactFlash Association.
F = If the device does not implement the CFA feature set (see 4.7), this command code is Vendor specific.
M = Reserved for the Media Card Pass Through Command feature set.
S = Reserved for Serial ATA.
*Indicates this definition is new to ACS-2.

Table B.4 — Historical Command Assignments (part 2 of 9)

Opcode	Command Name	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2
20h	READ SECTORS	C	C	C	C	C	C	C	C	C
21h	READ SECTORS WITHOUT RETRY	C	C	C	C	O	O	O	O	O
22h	READ LONG	C	C	C	O	O	O	O	O	O
23h	READ LONG WITHOUT RETRY	C	C	C	O	O	O	O	O	O
24h	READ SECTORS EXT	R	R	R	R	R	C	C	C	C
25h	READ DMA EXT	R	R	R	R	R	C	C	C	C
26h	READ DMA QUEUED EXT	R	R	R	R	R	C	C	C	O
27h	READ NATIVE MAX ADDRESS EXT	R	R	R	R	R	C	C	C	C
28h		R	R	R	R	R	R	R	R	R
29h	READ MULTIPLE EXT	R	R	R	R	R	C	C	C	C
2Ah	READ STREAM DMA	R	R	R	R	R	R	C	C	C
2Bh	READ STREAM	R	R	R	R	R	R	C	C	C
2Ch		R	R	R	R	R	R	R	R	R
2Dh		R	R	R	R	R	R	R	R	R
2Eh		R	R	R	R	R	R	R	R	R
2Fh	READ LOG EXT	R	R	R	R	R	C	C	C	C
30h	WRITE SECTORS	C	C	C	C	C	C	C	C	C
31h	WRITE SECTORS WITHOUT RETRY	C	C	C	C	O	O	O	O	O
32h	WRITE LONG	C	C	C	O	O	O	O	O	O
33h	WRITE LONG WITHOUT RETRY	C	C	C	O	O	O	O	O	O
34h	WRITE SECTORS EXT	R	R	R	R	O	C	C	C	C
35h	WRITE DMA EXT	R	R	R	R	R	C	C	C	C
36h	WRITE DMA QUEUED EXT	R	R	R	R	R	C	C	C	O
37h	SET NATIVE MAX ADDRESS EXT	R	R	R	R	R	C	C	C	C
38h	CFA WRITE SECTORS WITHOUT ERASE	R	R	R	C	C	C	C	C	C
39h	WRITE MULTIPLE EXT	R	R	R	R	R	C	C	C	C
3Ah	WRITE STREAM DMA	R	R	R	R	R	R	C	C	C
3Bh	WRITE STREAM	R	R	R	R	R	R	C	C	C
3Ch	WRITE VERIFY	C	C	C	O	O	O	O	O	O

Key:
C = a defined command.
E = a retired command.
O = Obsolete.
R = Reserved, undefined in current specifications.
V = Vendor specific commands.

A = Reserved for assignment by the CompactFlash Association.
F = If the device does not implement the CFA feature set (see 4.7), this command code is Vendor specific.
M = Reserved for the Media Card Pass Through Command feature set.
S = Reserved for Serial ATA.
*Indicates this definition is new to ACS-2.

Table B.4 — Historical Command Assignments (part 3 of 9)

Opcode	Command Name	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2
3Dh	WRITE DMA FUA EXT	R	R	R	R	R	R	C	C	C
3Eh	WRITE DMA QUEUED FUA EXT	R	R	R	R	R	R	C	C	O
3Fh	WRITE LOG EXT	R	R	R	R	R	C	C	C	C
40h	READ VERIFY SECTORS	C	C	C	C	C	C	C	C	C
41h	READ VERIFY SECTORS WITHOUT RETRY	C	C	C	C	O	O	O	O	O
42h	READ VERIFY SECTORS EXT	R	R	R	R	R	C	C	C	C
43h		R	R	R	R	R	R	R	R	R
44h		R	R	R	R	R	R	R	R	R
45h	WRITE UNCORRECTABLE EXT	R	R	R	R	R	R	R	C	C
46h		R	R	R	R	R	R	R	R	R
47h	READ LOG DMA EXT	R	R	R	R	R	R	R	C	C
48h		R	R	R	R	R	R	R	R	R
49h		R	R	R	R	R	R	R	R	R
4Ah		R	R	R	R	R	R	R	R	R
4Bh		R	R	R	R	R	R	R	R	R
4Ch		R	R	R	R	R	R	R	R	R
4Dh		R	R	R	R	R	R	R	R	R
4Eh		R	R	R	R	R	R	R	R	R
4Fh		R	R	R	R	R	R	R	R	R
50h	FORMAT TRACK	C	C	C	O	O	O	O	O	O
51h	CONFIGURE STREAM	R	R	R	R	R	R	C	C	C
52h		R	R	R	R	R	R	R	R	R
53h		R	R	R	R	R	R	R	R	R
54h		R	R	R	R	R	R	R	R	R
55h		R	R	R	R	R	R	R	R	R
56h		R	R	R	R	R	R	R	R	R
57h	WRITE LOG DMA EXT	R	R	R	R	R	R	R	C	C
58h		R	R	R	R	R	R	R	R	R
59h		R	R	R	R	R	R	R	R	R
5Ah		R	R	R	R	R	R	R	R	R
5Bh	TRUSTED NON-DATA	R	R	R	R	R	R	R	C	C
5Ch	TRUSTED RECEIVE	R	R	R	R	R	R	R	C	C

Key:
C = a defined command.
E = a retired command.
O = Obsolete.
R = Reserved, undefined in current specifications.
V = Vendor specific commands.

A = Reserved for assignment by the CompactFlash Association.
F = If the device does not implement the CFA feature set (see 4.7), this command code is Vendor specific.
M = Reserved for the Media Card Pass Through Command feature set.
S = Reserved for Serial ATA.
*Indicates this definition is new to ACS-2.

Table B.4 — Historical Command Assignments (part 4 of 9)

Opcode	Command Name	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2
5Dh	TRUSTED RECEIVE DMA	R	R	R	R	R	R	R	C	C
5Eh	TRUSTED SEND	R	R	R	R	R	R	R	C	C
5Fh	TRUSTED SEND DMA	R	R	R	R	R	R	R	C	C
60h	READ FPDMA QUEUED	R	R	R	R	R	R	S	C	C
61h	WRITE FPDMA QUEUED	R	R	R	R	R	R	S	C	C
62h	SATA (reserved)	R	R	R	R	R	R	S	S	S
63h	SATA (reserved)	R	R	R	R	R	R	S	S	S
64h	SATA (reserved)	R	R	R	R	R	R	S	S	S
65h	SATA (reserved)	R	R	R	R	R	R	S	S	S
66h	SATA (reserved)	R	R	R	R	R	R	S	S	S
67h	SATA (reserved)	R	R	R	R	R	R	S	S	S
68h		R	R	R	R	R	R	S	S	S
69h		R	R	R	R	R	R	S	S	S
6Ah		R	R	R	R	R	R	S	S	S
6Bh		R	R	R	R	R	R	S	S	S
6Ch		R	R	R	R	R	R	S	S	S
6Dh		R	R	R	R	R	R	S	S	S
6Eh		R	R	R	R	R	R	S	S	S
6Fh		R	R	R	R	R	R	S	S	S
70h	SEEK	C	C	C	C	C	C	O	O	O
71h	SEEK	C	C	O	E	E	E	E	E	E
72h	SEEK	C	C	O	E	E	E	E	E	E
73h	SEEK	C	C	O	E	E	E	E	E	E
74h	SEEK	C	C	O	E	E	E	E	E	E
75h	SEEK	C	C	O	E	E	E	E	E	E
76h	SEEK	C	C	O	E	E	E	E	E	E
77h	SEEK	C	C	O	E	E	E	E	E	E
78h	SEEK	C	C	O	E	E	E	E	E	E
79h	SEEK	C	C	O	E	E	E	E	E	E
7Ah	SEEK	C	C	O	E	E	E	E	E	E
7Bh	SEEK	C	C	O	E	E	E	E	E	E
7Ch	SEEK	C	C	O	E	E	E	E	E	E
7Dh	SEEK	C	C	O	E	E	E	E	E	E
7Eh	SEEK	C	C	O	E	E	E	E	E	E
7Fh	SEEK	C	C	O	E	E	E	E	E	E

Key:
- C = a defined command.
- E = a retired command.
- O = Obsolete.
- R = Reserved, undefined in current specifications.
- V = Vendor specific commands.

A = Reserved for assignment by the CompactFlash Association.
F = If the device does not implement the CFA feature set (see 4.7), this command code is Vendor specific.
M = Reserved for the Media Card Pass Through Command feature set.
S = Reserved for Serial ATA.
*Indicates this definition is new to ACS-2.

Table B.4 — Historical Command Assignments (part 5 of 9)

Opcode	Command Name	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2
80h	(vendor specific)	V	V	V	V	V	V	V	V	V
81h	(vendor specific)	V	V	V	V	V	V	V	V	V
82h	(vendor specific)	V	V	V	V	V	V	V	V	V
83h	(vendor specific)	V	V	V	V	V	V	V	V	V
84h	(vendor specific)	V	V	V	V	V	V	V	V	V
85h	(vendor specific)	V	V	V	V	V	V	V	V	V
86h	(vendor specific)	V	V	V	V	V	V	V	V	V
87h	(vendor specific) / CFA TRANSLATE SECTOR	V	V	V	F	F	F	F	F	F
88h	(vendor specific)	V	V	V	V	V	V	V	V	V
89h	(vendor specific)	V	V	V	V	V	V	V	V	V
8Ah	(vendor specific)	V	V	V	V	V	V	V	V	V
8Bh	(vendor specific)	V	V	V	V	V	V	V	V	V
8Ch	(vendor specific)	V	V	V	V	V	V	V	V	V
8Dh	(vendor specific)	V	V	V	V	V	V	V	V	V
8Eh	(vendor specific)	V	V	V	V	V	V	V	V	V
8Fh	(vendor specific)	V	V	V	V	V	V	V	V	V
90h	EXECUTE DEVICE DIAGNOSTICS	C	C	C	C	C	C	C	C	C
91h	INITIALIZE DEVICE PARAMETERS	C	C	C	C	C	O	O	O	O
92h	DOWNLOAD MICROCODE	R	C	C	C	C	C	C	C	C
93h	DOWNLOAD MICROCODE DMA	R	R	R	R	R	R	R	R	C*
94h	STANDBY IMMEDIATE	C	C	C	E	E	E	E	E	E
95h	IDLE IMMEDIATE	C	C	C	E	E	E	E	E	E
96h	STANDBY	C	C	C	E	E	E	E	E	E
97h	IDLE	C	C	C	E	E	E	E	E	E
98h	CHECK POWER MODE	C	C	C	E	E	E	E	E	E
99h	SLEEP	C	C	C	E	E	E	E	E	E
9Ah	(vendor specific)	V	V	V	V	V	V	V	V	V
9Bh		R	R	R	R	R	R	R	R	R
9Ch		R	R	R	R	R	R	R	R	R
9Dh		R	R	R	R	R	R	R	R	R
9Eh		R	R	R	R	R	R	R	R	R
9Fh		R	R	R	R	R	R	R	R	R

Key:	
C = a defined command.	A = Reserved for assignment by the CompactFlash Association.
E = a retired command.	F = If the device does not implement the CFA feature set (see 4.7), this command code is Vendor specific.
O = Obsolete.	M = Reserved for the Media Card Pass Through Command feature set.
R = Reserved, undefined in current specifications.	S = Reserved for Serial ATA.
V = Vendor specific commands.	*Indicates this definition is new to ACS-2.

Table B.4 — Historical Command Assignments (part 6 of 9)

Opcode	Command Name	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2
A0h	PACKET	R	R	C	C	C	C	C	C	C
A1h	IDENTIFY PACKET DEVICE	R	R	C	C	C	C	C	C	C
A2h	SERVICE	R	R	C	C	C	C	C	C	O
A3h		R	R	R	R	R	R	R	R	R
A4h		R	R	R	R	R	R	R	R	R
A5h		R	R	R	R	R	R	R	R	R
A6h		R	R	R	R	R	R	R	R	R
A7h		R	R	R	R	R	R	R	R	R
A8h		R	R	R	R	R	R	R	R	R
A9h		R	R	R	R	R	R	R	R	R
AAh		R	R	R	R	R	R	R	R	R
ABh		R	R	R	R	R	R	R	R	R
ACh		R	R	R	R	R	R	R	R	R
ADh		R	R	R	R	R	R	R	R	R
AEh		R	R	R	R	R	R	R	R	R
AFh		R	R	R	R	R	R	R	R	R
B0h	SMART	R	R	C	C	C	C	C	C	C
B1h	CFA DEVICE CONFIGURATION	R	R	R	R	R	C	C	C	C
B2h		R	R	R	R	R	R	R	R	R
B3h		R	R	R	R	R	R	R	R	R
B4h	Sanitize Device	R	R	R	R	R	R	R	R	C*
B5h		R	R	R	R	R	R	R	R	R
B6h	NV CACHE	R	R	R	R	R	R	R	C	C
B7h	Reserved for the CompactFlash Association	R	R	R	R	R	R	R	R	R
B8h	Reserved for the CompactFlash Association	R	R	R	R	A	A	A	A	A
B9h	Reserved for the CompactFlash Association	R	R	R	R	A	A	A	A	A
BAh	Reserved for the CompactFlash Association	R	R	R	R	A	A	A	A	A
BBh	Reserved for the CompactFlash Association	R	R	R	R	A	A	A	A	A
BCh	Reserved	R	R	R	R	A	A	A	R	R
BDh	Reserved	R	R	R	R	A	A	A	R	R

Key:	
C = a defined command. E = a retired command. O = Obsolete. R = Reserved, undefined in current specifications. V = Vendor specific commands.	A = Reserved for assignment by the CompactFlash Association. F = If the device does not implement the CFA feature set (see 4.7), this command code is Vendor specific. M = Reserved for the Media Card Pass Through Command feature set. S = Reserved for Serial ATA. *Indicates this definition is new to ACS-2.

Table B.4 — Historical Command Assignments (part 7 of 9)

Opcode	Command Name	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2
BEh	Reserved	R	R	R	R	A	A	A	R	R
BFh	Reserved	R	R	R	R	A	A	A	R	R
C0h	(vendor specific) / CFA ERASE SECTORS	V	V	V	F	F	F	F	F	F
C1h	(vendor specific)	V	V	V	V	V	V	V	V	V
C2h	(vendor specific)	V	V	V	V	V	V	V	V	V
C3h	(vendor specific)	V	V	V	V	V	V	V	V	V
C4h	READ MULTIPLE	C	C	C	C	C	C	C	C	C
C5h	WRITE MULTIPLE	C	C	C	C	C	C	C	C	C
C6h	SET MULTIPLE MODE	C	C	C	C	C	C	C	C	C
C7h	READ DMA QUEUED	R	R	R	C	C	C	C	C	O
C8h	READ DMA	C	C	C	C	C	C	C	C	C
C9h	READ DMA WITHOUT RETRIES	C	C	C	C	O	O	O	O	O
CAh	WRITE DMA	C	C	C	C	C	C	C	C	C
CBh	WRITE DMA WITHOUT RETRIES	C	C	C	C	O	O	O	O	O
CCh	WRITE DMA QUEUED	R	R	R	C	C	C	C	C	O
CDh	CFA WRITE MULTIPLE WITHOUT ERASE	R	R	R	C	C	C	C	C	C
CEh	WRITE MULTIPLE FUA EXT	R	R	R	R	R	R	C	C	C
CFh		R	R	R	R	R	R	R	R	R
D0h		R	R	R	R	R	R	R	R	R
D1h	CHECK MEDIA CARD TYPE	R	R	R	R	R	C	C	C	C
D2h	Reserved for the Media Card Pass Through Command feature set	R	R	R	R	R	M	M	M	M
D3h	Reserved for the Media Card Pass Through Command feature set	R	R	R	R	R	M	M	M	M
D4h	Reserved for the Media Card Pass Through Command feature set	R	R	R	R	R	M	M	M	M
D5h		R	R	R	R	R	R	R	R	R
D6h		R	R	R	R	R	R	R	R	R
D7h		R	R	R	R	R	R	R	R	R
D8h		R	R	R	R	R	R	R	R	R

Key:	
C = a defined command.	A = Reserved for assignment by the CompactFlash Association.
E = a retired command.	F = If the device does not implement the CFA feature set (see 4.7), this command code is Vendor specific.
O = Obsolete.	
R = Reserved, undefined in current specifications.	M = Reserved for the Media Card Pass Through Command feature set.
V = Vendor specific commands.	S = Reserved for Serial ATA.
	*Indicates this definition is new to ACS-2.

Table B.4 — Historical Command Assignments (part 8 of 9)

Opcode	Command Name	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2
D9h		R	R	R	R	R	R	R	R	R
DAh	GET MEDIA STATUS	R	R	R	C	C	C	C	O	O
DBh	ACKNOWLEDGE MEDIA CHANGE	C	C	O	E	E	E	E	E	E
DCh	BOOT POST BOOT	C	C	O	E	E	E	E	E	E
DDh	BOOT PRE BOOT	C	C	O	E	E	E	E	E	E
DEh	MEDIA LOCK	C	C	C	C	C	C	C	O	O
DFh	MEDIA UNLOCK	C	C	C	C	C	C	C	O	O
E0h	STANDBY IMMEDIATE	C	C	C	C	C	C	C	C	C
E1h	IDLE IMMEDIATE	C	C	C	C	C	C	C	C	C
E2h	STANDBY	C	C	C	C	C	C	C	C	C
E3h	IDLE	C	C	C	C	C	C	C	C	C
E4h	READ BUFFER	C	C	C	C	C	C	C	C	C
E5h	CHECK POWER MODE	C	C	C	C	C	C	C	C	C
E6h	SLEEP	C	C	C	C	C	C	C	C	C
E7h	FLUSH CACHE	R	R	R	C	C	C	C	C	C
E8h	WRITE BUFFER	C	C	C	C	C	C	C	C	C
E9h	(WRITE SAME) READ BUFFER DMA	C	C	O	E	E	E	E	E	C*
EAh	FLUSH CACHE EXT	R	R	R	R	R	C	C	C	C
EBh	WRITE BUFFER DMA	R	R	R	R	R	R	R	R	C*

Key:
    C = a defined command.
    E = a retired command.
    O = Obsolete.
    R = Reserved, undefined in
        current specifications.
    V = Vendor specific commands.

A = Reserved for assignment by the CompactFlash Association.
F = If the device does not implement the CFA feature set (see 4.7), this command code is Vendor specific.
M = Reserved for the Media Card Pass Through Command feature set.
S = Reserved for Serial ATA.
*Indicates this definition is new to ACS-2.

Table B.4 — Historical Command Assignments (part 9 of 9)

Opcode	Command Name	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2
ECh	IDENTIFY DEVICE	C	C	C	C	C	C	C	C	C
EDh	MEDIA EJECT	R	C	C	C	C	C	C	O	O
EEh	IDENTIFY DEVICE DMA	R	R	C	O	O	O	O	O	O
EFh	SET FEATURES	C	C	C	C	C	C	C	C	C
F0h	(vendor specific)	V	V	V	V	V	V	V	V	V
F1h	SECURITY SET PASSWORD	V	V	C	C	C	C	C	C	C
F2h	SECURITY UNLOCK	V	V	C	C	C	C	C	C	C
F3h	SECURITY ERASE PREPARE	V	V	C	C	C	C	C	C	C
F4h	SECURITY ERASE UNIT	V	V	C	C	C	C	C	C	C
F5h	SECURITY FREEZE LOCK	V	V	C	C	C	C	C	C	C
F6h	SECURITY DISABLE PASSWORD	V	V	C	C	C	C	C	C	C
F7h	(vendor specific)	V	V	V	V	V	V	V	V	V
F8h	READ NATIVE MAX ADDRESS	V	V	V	C	C	C	C	C	C
F9h	SET MAX ADDRESS	V	V	V	C	C	C	C	C	C
FAh	(vendor specific)	V	V	V	V	V	V	V	V	V
FBh	(vendor specific)	V	V	V	V	V	V	V	V	V
FCh	(vendor specific)	V	V	V	V	V	V	V	V	V
FDh	(vendor specific)	V	V	V	V	V	V	V	V	V
FEh	(vendor specific)	V	V	V	V	V	V	V	V	V
FFh	(vendor specific)	V	V	V	V	V	V	V	V	V

Key:
C = a defined command.
E = a retired command.
O = Obsolete.
R = Reserved, undefined in current specifications.
V = Vendor specific commands.

A = Reserved for assignment by the CompactFlash Association.
F = If the device does not implement the CFA feature set (see 4.7), this command code is Vendor specific.
M = Reserved for the Media Card Pass Through Command feature set.
S = Reserved for Serial ATA.
*Indicates this definition is new to ACS-2.

Table B.5 — Historical SET FEATURE Code Assignments (part 1 of 9)

Feature Code	Description	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2
01h	Enable 8-bit data transfers	C	C	O	E	F	F	F	F	F
02h	Enable write cache	V	V	C	C	C	C	C	C	C
03h	Set transfer mode	C	C	C	C	C	C	C	C	C
04h	Enable all automatic defect reassignment	R	R	C	O	O	O	O	O	O
05h	Enable advanced power management	R	R	R	C	C	C	C	C	C
06h	Enable Power-Up in Standby feature set	R	R	R	R	C	C	C	C	C
07h	Power-up in Standby feature set device spin-up	R	R	R	R	C	C	C	C	C
09h	Reserved for Address offset reserved boot area method technical report	R	R	R	R	C	C	C	C	C
0Ah	Enable CFA power mode 1	R	R	R	R	C	C	C	C	C
0Bh	Reserved	R	R	R	R	R	R	R	R	R
0Ch	Reserved	R	R	R	R	R	R	R	R	R
0Dh	Reserved	R	R	R	R	R	R	R	R	R
0Eh	Reserved	R	R	R	R	R	R	R	R	R
0Fh	Reserved	R	R	R	R	R	R	R	R	R
10h	Enable use of SATA feature	R	R	R	R	R	R	S	C	C
11h	Reserved	R	R	R	R	R	R	R	R	R
12h	Reserved	R	R	R	R	R	R	R	R	R
13h	Reserved	R	R	R	R	R	R	R	R	R
14h	Reserved	R	R	R	R	R	R	R	R	R
15h	Reserved	R	R	R	R	R	R	R	R	R
16h	Reserved	R	R	R	R	R	R	R	R	R
17h	Reserved	R	R	R	R	R	R	R	R	R
18h	Reserved	R	R	R	R	R	R	R	R	R
19h	Reserved	R	R	R	R	R	R	R	R	R
1Ah	Reserved	R	R	R	R	R	R	R	R	R
1Bh	Reserved	R	R	R	R	R	R	R	R	R

Key:

C = a defined command.
E = a retired command.
O = Obsolete.
R = Reserved, undefined in current specifications.
V = Vendor specific command.
A = Reserved for assignment by the CompactFlash Association.

F = If the device does not implement the CFA feature set (see 4.7), this command code is Vendor specific.
M = Reserved for the Media Card Pass Through Command feature set.
S = Reserved for Serial ATA.
T = Reserved for Technical Report T13/DT1696 (Time-Limited Commands).
*Indicates this definition is new to ACS-2

Table B.5 — Historical SET FEATURE Code Assignments (part 2 of 9)

Feature Code	Description	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2
1Ch	Reserved	R	R	R	R	R	R	R	R	R
1Dh	Reserved	R	R	R	R	R	R	R	R	R
1Eh	Reserved	R	R	R	R	R	R	R	R	R
1Fh	Reserved	R	R	R	R	R	R	R	R	R
20h	Reserved for Technical Report (T13/DT1696)	R	R	R	R	R	R	T	T	T
21h	Reserved for Technical Report (T13/DT1696)	R	R	R	R	R	R	T	T	T
22h	Reserved	R	R	R	R	R	R	R	R	R
23h	Reserved	R	R	R	R	R	R	R	R	R
24h	Reserved	R	R	R	R	R	R	R	R	R
25h	Reserved	R	R	R	R	R	R	R	R	R
26h	Reserved	R	R	R	R	R	R	R	R	R
27h	Reserved	R	R	R	R	R	R	R	R	R
28h	Reserved	R	R	R	R	R	R	R	R	R
29h	Reserved	R	R	R	R	R	R	R	R	R
2Ah	Reserved	R	R	R	R	R	R	R	R	R
2Bh	Reserved	R	R	R	R	R	R	R	R	R
2Ch	Reserved	R	R	R	R	R	R	R	R	R
2Dh	Reserved	R	R	R	R	R	R	R	R	R
2Eh	Reserved	R	R	R	R	R	R	R	R	R
2Fh	Reserved	R	R	R	R	R	R	R	R	R
30h	Reserved	R	R	R	R	R	R	R	R	R
31h	Disable Media Status Notification	R	R	R	C	C	C	C	O	O
32h	Reserved	R	R	R	R	R	R	R	R	R
33h	Disable retry	V	V	C	C	O	O	O	O	O
34h	Reserved	R	R	R	R	R	R	R	R	R
35h	Reserved	R	R	R	R	R	R	R	R	R
36h	Reserved	R	R	R	R	R	R	R	R	R
37h	Reserved	R	R	R	R	R	R	R	R	R
38h	Reserved	R	R	R	R	R	R	R	R	R
39h	Reserved	R	R	R	R	R	R	R	R	R

Key:

C = a defined command.
E = a retired command.
O = Obsolete.
R = Reserved, undefined in current specifications.
V = Vendor specific command.
A = Reserved for assignment by the CompactFlash Association.

F = If the device does not implement the CFA feature set (see 4.7), this command code is Vendor specific.
M = Reserved for the Media Card Pass Through Command feature set.
S = Reserved for Serial ATA.
T = Reserved for Technical Report T13/DT1696 (Time-Limited Commands).
*Indicates this definition is new to ACS-2

Table B.5 — Historical SET FEATURE Code Assignments (part 3 of 9)

Feature Code	Description	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2
3Ah	Reserved	R	R	R	R	R	R	R	R	R
3Bh	Reserved	R	R	R	R	R	R	R	R	R
3Ch	Reserved	R	R	R	R	R	R	R	R	R
3Dh	Reserved	R	R	R	R	R	R	R	R	R
3Eh	Reserved	R	R	R	R	R	R	R	R	R
3Fh	Reserved	R	R	R	R	R	R	R	R	R
40h	Reserved	R	R	R	R	R	R	R	R	R
41h	Enable Free-fall Control feature set	R	R	R	R	R	R	R	C	C
42h	Enable Automatic Acoustic Management feature set	R	R	R	R	R	R	C	C	C
43h	Set Maximum Host Interface Sector Times	R	R	R	R	R	R	C	C	C
44h	Vendor specific length of ECC on read long/write long commands	C	C	C	O	O	O	O	O	O
45h	Reserved	R	R	R	R	R	R	R	R	R
46h	Reserved	R	R	R	R	R	R	R	R	R
47h	Reserved	R	R	R	R	R	R	R	R	R
48h	Reserved	R	R	R	R	R	R	R	R	R
49h	Reserved	R	R	R	R	R	R	R	R	R
4Ah	Extended Power Conditions	R	R	R	R	R	R	R	R	C*
4Bh	Reserved	R	R	R	R	R	R	R	R	R
4Ch	Reserved	R	R	R	R	R	R	R	R	R
4Dh	Reserved	R	R	R	R	R	R	R	R	R
4Eh	Reserved	R	R	R	R	R	R	R	R	R
4Fh	Reserved	R	R	R	R	R	R	R	R	R
50h	Reserved	R	R	R	R	R	R	R	R	R
51h	Reserved	R	R	R	R	R	R	R	R	R
52h	Reserved	R	R	R	R	R	R	R	R	R
53h	Reserved	R	R	R	R	R	R	R	R	R
54h	Set cache segments to the Count field value	V	V	C	O	O	O	O	O	O

Key:

C = a defined command.
E = a retired command.
O = Obsolete.
R = Reserved, undefined in current specifications.
V = Vendor specific command.
A = Reserved for assignment by the CompactFlash Association.

F = If the device does not implement the CFA feature set (see 4.7), this command code is Vendor specific.
M = Reserved for the Media Card Pass Through Command feature set.
S = Reserved for Serial ATA.
T = Reserved for Technical Report T13/DT1696 (Time-Limited Commands).
*Indicates this definition is new to ACS-2

Table B.5 — Historical SET FEATURE Code Assignments (part 4 of 9)

Feature Code	Description	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2
55h	Disable read look-ahead feature	C	C	C	C	C	C	C	C	C
56h	Vendor Specific	R	R	R	R	R	R	R	V	V
57h	Vendor Specific	R	R	R	R	R	R	R	V	V
58h	Vendor Specific	R	R	R	R	R	R	R	V	V
59h	Vendor Specific	R	R	R	R	R	R	R	V	V
5Ah	Vendor Specific	R	R	R	R	R	R	R	V	V
5Bh	Vendor Specific	R	R	R	R	R	R	R	V	V
5Ch	Vendor Specific	R	R	R	R	R	R	R	V	V
5Dh	Enable release interrupt	R	R	R	C	C	C	C	C	O*
5Eh	Enable SERVICE interrupt	R	R	R	C	C	C	C	C	O*
5Fh	Reserved	R	R	R	R	R	R	R	R	R
60h	Reserved	R	R	R	R	R	R	R	R	R
61h	Reserved	R	R	R	R	R	R	R	R	R
62h	Reserved	R	R	R	R	R	R	R	R	R
63h	Reserved	R	R	R	R	R	R	R	R	R
64h	Reserved	R	R	R	R	R	R	R	R	R
65h	Reserved	R	R	R	R	R	R	R	R	R
66h	Disable reverting to power on defaults	C	C	C	C	C	C	C	C	C
67h	Reserved	R	R	R	R	R	R	R	R	R
68h	Reserved	R	R	R	R	R	R	R	R	R
69h	Long Physical Sector Alignment Error Reporting Control	R	R	R	R	R	R	R	R	C*
6Ah	Reserved	R	R	R	R	R	R	R	R	R
6Bh	Reserved	R	R	R	R	R	R	R	R	R
6Ch	Reserved	R	R	R	R	R	R	R	R	R
6Dh	Reserved	R	R	R	R	R	R	R	R	R
6Eh	Reserved	R	R	R	R	R	R	R	R	R
6Fh	Reserved	R	R	R	R	R	R	R	R	R
70h	Reserved	R	R	R	R	R	R	R	R	R
71h	Reserved	R	R	R	R	R	R	R	R	R

Key:

  C = a defined command.
  E = a retired command.
  O = Obsolete.
  R = Reserved, undefined in current specifications.
  V = Vendor specific command.
  A = Reserved for assignment by the CompactFlash Association.

F = If the device does not implement the CFA feature set (see 4.7), this command code is Vendor specific.
M = Reserved for the Media Card Pass Through Command feature set.
S = Reserved for Serial ATA.
T = Reserved for Technical Report T13/DT1696 (Time-Limited Commands).
*Indicates this definition is new to ACS-2

Table B.5 — Historical SET FEATURE Code Assignments (part 5 of 9)

Feature Code	Description	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2
72h	Reserved	R	R	R	R	R	R	R	R	R
73h	Reserved	R	R	R	R	R	R	R	R	R
74h	Reserved	R	R	R	R	R	R	R	R	R
75h	Reserved	R	R	R	R	R	R	R	R	R
76h	Reserved	R	R	R	R	R	R	R	R	R
77h	Disable ECC	V	V	C	O	O	O	O	O	O
78h	Reserved	R	R	R	R	R	R	R	R	R
79h	Reserved	R	R	R	R	R	R	R	R	R
7Ah	Reserved	R	R	R	R	R	R	R	R	R
7Bh	Reserved	R	R	R	R	R	R	R	R	R
7Ch	Reserved	R	R	R	R	R	R	R	R	R
7Dh	Reserved	R	R	R	R	R	R	R	R	R
7Eh	Reserved	R	R	R	R	R	R	R	R	R
7Fh	Reserved	R	R	R	R	R	R	R	R	R
80h	Reserved	R	R	R	R	R	R	R	R	R
81h	Disable 8-bit data transfers	C	C	O	E	F	F	F	F	F
82h	Disable write cache	V	V	C	C	C	C	C	C	C
83h	Reserved	R	R	R	R	R	R	R	R	R
84h	Disable all automatic defect reassignment	R	R	C	O	O	O	O	O	O
85h	Disable advanced power management	R	R	R	C	C	C	C	C	C
86h	Disable Power-Up in Standby feature set	R	R	R	R	C	C	C	C	C
87h	Reserved	R	R	R	R	R	R	R	R	R
88h	Enable ECC	V	V	C	C	C	O	O	O	O
89h	Reserved for Address offset reserved boot area method technical report	R	R	R	R	C	C	C	C	C
8Ah	Disable CFA power mode 1	R	R	R	R	C	C	F	F	F
8Bh	Reserved	R	R	R	R	R	R	R	R	R
8Ch	Reserved	R	R	R	R	R	R	R	R	R
8Dh	Reserved	R	R	R	R	R	R	R	R	R

Key:

C = a defined command.
E = a retired command.
O = Obsolete.
R = Reserved, undefined in current specifications.
V = Vendor specific command.
A = Reserved for assignment by the CompactFlash Association.

F = If the device does not implement the CFA feature set (see 4.7), this command code is Vendor specific.
M = Reserved for the Media Card Pass Through Command feature set.
S = Reserved for Serial ATA.
T = Reserved for Technical Report T13/DT1696 (Time-Limited Commands).
*Indicates this definition is new to ACS-2

Table B.5 — Historical SET FEATURE Code Assignments (part 6 of 9)

Feature Code	Description	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2
8Eh	Reserved	R	R	R	R	R	R	R	R	R
8Fh	Reserved	R	R	R	R	R	R	R	R	R
90h	Disable use of SATA feature	R	R	R	R	R	R	S	C	C
91h	Reserved	R	R	R	R	R	R	R	R	R
92h	Reserved	R	R	R	R	R	R	R	R	R
93h	Reserved	R	R	R	R	R	R	R	R	R
94h	Reserved	R	R	R	R	R	R	R	R	R
95h	Enable Media Status Notification	R	R	R	C	C	C	C	O	O
96h	Reserved	R	R	R	R	R	R	R	R	R
97h	Reserved	R	R	R	R	R	R	R	R	R
98h	Reserved	R	R	R	R	R	R	R	R	R
99h	Enable retries	V	V	C	O	O	O	O	O	O
9Ah	Set device maximum average current	R	R	C	O	O	O	O	O	O
9Bh	Reserved	R	R	R	R	R	R	R	R	R
9Ch	Reserved	R	R	R	R	R	R	R	R	R
9Dh	Reserved	R	R	R	R	R	R	R	R	R
9Eh	Reserved	R	R	R	R	R	R	R	R	R
9Fh	Reserved	R	R	R	R	R	R	R	R	R
A0h	Reserved	R	R	R	R	R	R	R	R	R
A1h	Reserved	R	R	R	R	R	R	R	R	R
A2h	Reserved	R	R	R	R	R	R	R	R	R
A3h	Reserved	R	R	R	R	R	R	R	R	R
A4h	Reserved	R	R	R	R	R	R	R	R	R
A5h	Reserved	R	R	R	R	R	R	R	R	R
A6h	Reserved	R	R	R	R	R	R	R	R	R
A7h	Reserved	R	R	R	R	R	R	R	R	R
A8h	Reserved	R	R	R	R	R	R	R	R	R
A9h	Reserved	R	R	R	R	R	R	R	R	R
AAh	Enable read look-ahead features	C	C	C	C	C	C	C	C	C

Key:

C = a defined command.
E = a retired command.
O = Obsolete.
R = Reserved, undefined in current specifications.
V = Vendor specific command.
A = Reserved for assignment by the CompactFlash Association.

F = If the device does not implement the CFA feature set (see 4.7), this command code is Vendor specific.
M = Reserved for the Media Card Pass Through Command feature set.
S = Reserved for Serial ATA.
T = Reserved for Technical Report T13/DT1696 (Time-Limited Commands).
*Indicates this definition is new to ACS-2

Table B.5 — Historical SET FEATURE Code Assignments (part 7 of 9)

Feature Code	Description	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2
ABh	Set maximum prefetch using the Count field value	V	V	C	O	O	O	O	O	O
ACh	Reserved	R	R	R	R	R	R	R	R	R
ADh	Reserved	R	R	R	R	R	R	R	R	R
AEh	Reserved	R	R	R	R	R	R	R	R	R
AFh	Reserved	R	R	R	R	R	R	R	R	R
B0h	Reserved	R	R	R	R	R	R	R	R	R
B1h	Reserved	R	R	R	R	R	R	R	R	R
B2h	Reserved	R	R	R	R	R	R	R	R	R
B3h	Reserved	R	R	R	R	R	R	R	R	R
B4h	Reserved	R	R	R	R	R	R	R	R	R
B5h	Reserved	R	R	R	R	R	R	R	R	R
B6h	Reserved	R	R	R	R	R	R	R	R	R
B7h	Reserved	R	R	R	R	R	R	R	R	R
B8h	Reserved	R	R	R	R	R	R	R	R	R
B9h	Reserved	R	R	R	R	R	R	R	R	R
BAh	Reserved	R	R	R	R	R	R	R	R	R
BBh	4 bytes of ECC apply on read long/write long commands	C	C	C	O	O	O	O	O	O
BCh	Reserved	R	R	R	R	R	R	R	R	R
BDh	Reserved	R	R	R	R	R	R	R	R	R
BEh	Reserved	R	R	R	R	R	R	R	R	R
BFh	Reserved	R	R	R	R	R	R	R	R	R
C0h	Reserved	R	R	R	R	R	R	R	R	R
C1h	Disable Free-fall Control feature set	R	R	R	R	R	R	R	C	C
C2h	Disable Automatic Acoustic Management feature set	R	R	R	R	R	R	C	C	C
C3h	Enabled/Disable the Sense Data Reporting feature set	R	R	R	R	R	R	R	R	C
C4h	Reserved	R	R	R	R	R	R	R	R	R
C5h	Reserved	R	R	R	R	R	R	R	R	R
C6h	Reserved	R	R	R	R	R	R	R	R	R

Key:

  C = a defined command.
  E = a retired command.
  O = Obsolete.
  R = Reserved, undefined in current specifications.
  V = Vendor specific command.
  A = Reserved for assignment by the CompactFlash Association.

F = If the device does not implement the CFA feature set (see 4.7), this command code is Vendor specific.
M = Reserved for the Media Card Pass Through Command feature set.
S = Reserved for Serial ATA.
T = Reserved for Technical Report T13/DT1696 (Time-Limited Commands).
*Indicates this definition is new to ACS-2

Table B.5 — Historical SET FEATURE Code Assignments (part 8 of 9)

Feature Code	Description	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2
C7h	Reserved	R	R	R	R	R	R	R	R	R
C8h	Reserved	R	R	R	R	R	R	R	R	R
C9h	Reserved	R	R	R	R	R	R	R	R	R
CAh	Reserved	R	R	R	R	R	R	R	R	R
CBh	Reserved	R	R	R	R	R	R	R	R	R
CCh	Enable reverting to power on defaults	C	C	C	C	C	C	C	C	C
CDh	Reserved	R	R	R	R	R	R	R	R	R
CEh	Reserved	R	R	R	R	R	R	R	R	R
CFh	Reserved	R	R	R	R	R	R	R	R	R
D0h	Reserved	R	R	R	R	R	R	R	R	R
D1h	Reserved	R	R	R	R	R	R	R	R	R
D2h	Reserved	R	R	R	R	R	R	R	R	R
D3h	Reserved	R	R	R	R	R	R	R	R	R
D4h	Reserved	R	R	R	R	R	R	R	R	R
D5h	Reserved	R	R	R	R	R	R	R	R	R
D6h	Vendor Specific	R	R	R	R	R	R	R	V	V
D7h	Vendor Specific	R	R	R	R	R	R	R	V	V
D8h	Vendor Specific	R	R	R	R	R	R	R	V	V
D9h	Vendor Specific	R	R	R	R	R	R	R	V	V
DAh	Vendor Specific	R	R	R	R	R	R	R	V	V
DBh	Vendor Specific	R	R	R	R	R	R	R	V	V
DCh	Vendor Specific	R	R	R	R	R	R	R	V	V
DDh	Disable release interrupt	R	R	R	C	C	C	C	C	O*
DEh	Disable SERVICE interrupt	R	R	R	C	C	C	C	C	O*
DFh	Reserved	R	R	R	R	R	R	R	R	R
E0h	Vendor specific	R	R	R	R	R	R	O	O	O
E1h	Reserved	R	R	R	R	R	R	R	R	R
E2h	Reserved	R	R	R	R	R	R	R	R	R
E3h	Reserved	R	R	R	R	R	R	R	R	R
E4h	Reserved	R	R	R	R	R	R	R	R	R
E5h	Reserved	R	R	R	R	R	R	R	R	R

Key:

C = a defined command.
E = a retired command.
O = Obsolete.
R = Reserved, undefined in current specifications.
V = Vendor specific command.
A = Reserved for assignment by the CompactFlash Association.

F = If the device does not implement the CFA feature set (see 4.7), this command code is Vendor specific.
M = Reserved for the Media Card Pass Through Command feature set.
S = Reserved for Serial ATA.
T = Reserved for Technical Report T13/DT1696 (Time-Limited Commands).
*Indicates this definition is new to ACS-2

Table B.5 — Historical SET FEATURE Code Assignments (part 9 of 9)

Feature Code	Description	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2
E6h	Reserved	R	R	R	R	R	R	R	R	R
E7h	Reserved	R	R	R	R	R	R	R	R	R
E8h	Reserved	R	R	R	R	R	R	R	R	R
E9h	Reserved	R	R	R	R	R	R	R	R	R
EAh	Reserved	R	R	R	R	R	R	R	R	R
EBh	Reserved	R	R	R	R	R	R	R	R	R
ECh	Reserved	R	R	R	R	R	R	R	R	R
EDh	Reserved	R	R	R	R	R	R	R	R	R
EEh	Reserved	R	R	R	R	R	R	R	R	R
EFh	Reserved	R	R	R	R	R	R	R	R	R
F0h		R	R	R	R	A	A	A	A	A
F1h		R	R	R	R	A	A	A	A	A
F2h		R	R	R	R	A	A	A	A	A
F3h		R	R	R	R	A	A	A	A	A
F4h		R	R	R	R	A	A	A	A	A
F5h		R	R	R	R	A	A	A	A	A
F6h		R	R	R	R	A	A	A	A	A
F7h		R	R	R	R	A	A	A	A	A
F8h		R	R	R	R	A	A	A	A	A
F9h		R	R	R	R	A	A	A	A	A
FAh		R	R	R	R	A	A	A	A	A
FBh		R	R	R	R	A	A	A	A	A
FCh		R	R	R	R	A	A	A	A	A
FDh		R	R	R	R	A	A	A	A	A
FEh		R	R	R	R	A	A	A	A	A
FFh		R	R	R	R	A	A	A	A	A

Key:

C = a defined command.
E = a retired command.
O = Obsolete.
R = Reserved, undefined in current specifications.
V = Vendor specific command.
A = Reserved for assignment by the CompactFlash Association.

F = If the device does not implement the CFA feature set (see 4.7), this command code is Vendor specific.
M = Reserved for the Media Card Pass Through Command feature set.
S = Reserved for Serial ATA.
T = Reserved for Technical Report T13/DT1696 (Time-Limited Commands).
*Indicates this definition is new to ACS-2

Annex C

(Informative)

Design and programming considerations for large physical sector devices

C.1 Physical sectors

Because the 512-byte sector has been a constant since the beginning of ATA many software changes are required if device logical sectors were made larger . To preserve the legacy software that assumes a 512-byte logical sector, logical addressing based on 512-byte sectors has been retained . Larger physical sectors are implemented as power of two multiples of the logical sector size (e.g., 1, 2, 4, 8, 16) . For example, devices may have physical sectors that are eight logical sectors long (i.e., 4 096 bytes) . Reporting a logical sector that spans two physical sectors in not defined by this standard.

C.2 Unaligned write

While allowing a logical sector to be smaller than a physical sector maintains software compatibility, it introduces a potential performance issue (i.e., unaligned write) which should be avoided . A physical sector is written to the media in a single operation . To complete a write command that writes a fraction of a physical sector the device reads the entire physical sector into buffer memory, updates the buffer memory with the write data, then writes the entire physical sector to the media . This may incur a performance penalty of one media revolution or more.

Write commands may begin mid physical sector and end mid physical sector resulting in two unaligned writes . In this case the device has to read both the beginning and ending physical sector of the write into the buffer .

To avoid the performance penalty from an unaligned write, all write operations should begin with the first sector of a physical sector and end with the last sector of a physical sector .

Figure C.1 is an example of an unaligned write on a device with 2 048 byte physical sectors . The first four logical sectors, LBA 0 - LBA 3, reside on physical sector 0 . To write only LBA 3 the host sends a conventional write command and the data for LBA 3 . On receipt of the write command the device seeks to the physical sector that contains LBA 3, which is physical sector 0 . If physical sector 0 is read into the device's buffer, then the new write data for LBA 3 is placed in the buffer, overwriting a segment of the buffer . The buffer data is then written to the media, physical sector 0.
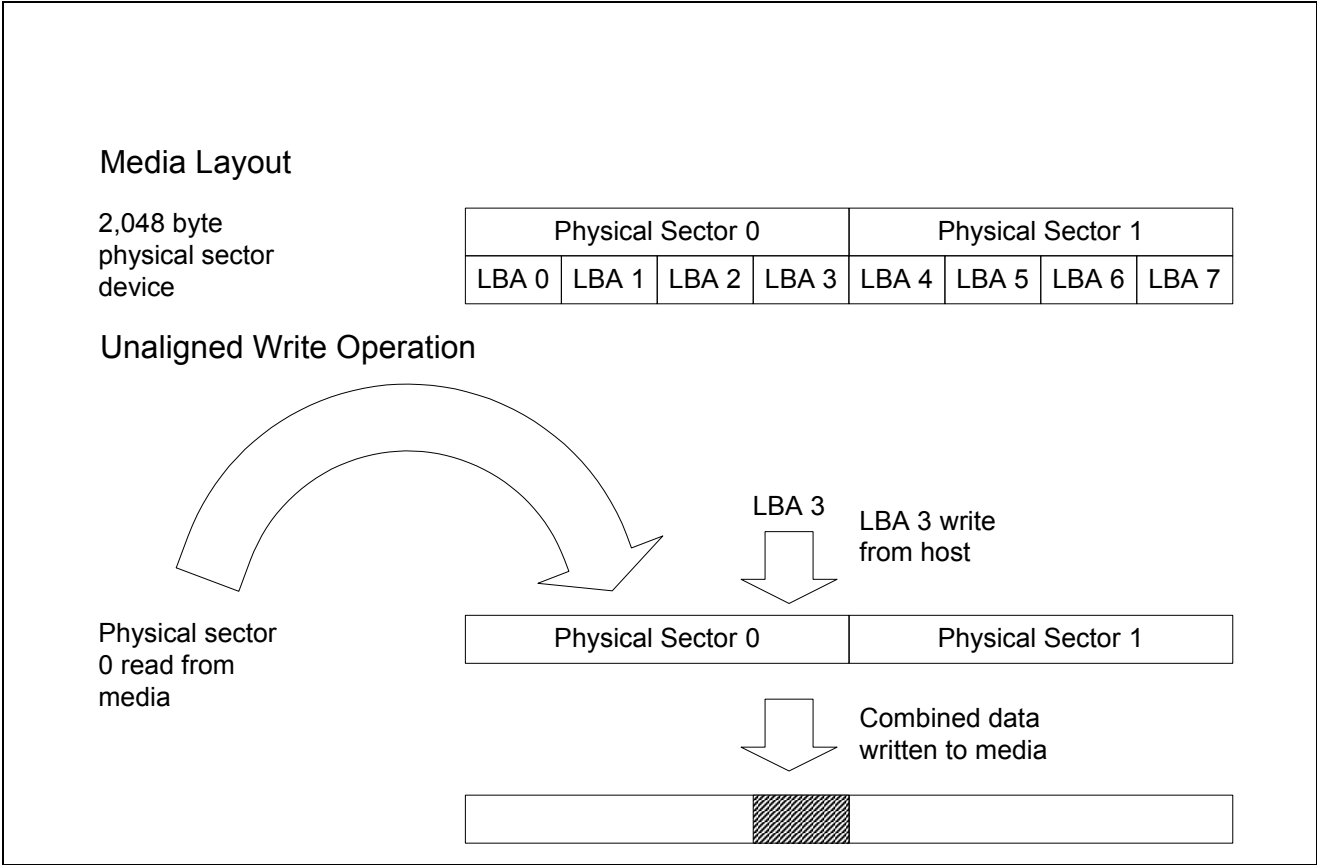
Figure C.1 — Unaligned Write Example

C.3 SET MAX

A Host that uses the SET MAX ADDRESS command (see 7.51.2) or SET MAX ADDRESS EXT command (see 7.52) should set a value to the last logical sector of a physical sector to allow writes to the end of the user area without requiring an unaligned write . Devices should accommodate a SET MAX setting to any LBA to maintain compatibility .

C.4 Software compatibility

Even though this specification allows devices to report up to 2^{15} (i.e., 32 768) logical sectors per physical sector there are file system limitations in existing systems that restrict practical device implementations to 4 096 bytes per physical sector.

Annex D
(Informative)

How to use SCT commands

D.1 How to use SCT commands overview

SCT commands use the following standard ATA commands:

    a)   SMART READ LOG;
    b)   SMART WRITE LOG;
    c)   READ LOG EXT;
    d)   READ LOG DMA EXT;
    e)   WRITE LOG EXT; and
    f)   WRITE LOG DMA EXT.

As viewed a the ATA transport, an SCT command is seen as data being transferred by these commands . However, from the perspective of a device that implements this feature set, this data is interpreted as an SCT command request, an SCT command response, SCT command status, or SCT command data.

Figure D.1 is an example flowchart that shows how to process SCT commands using read log commands and write log commands:
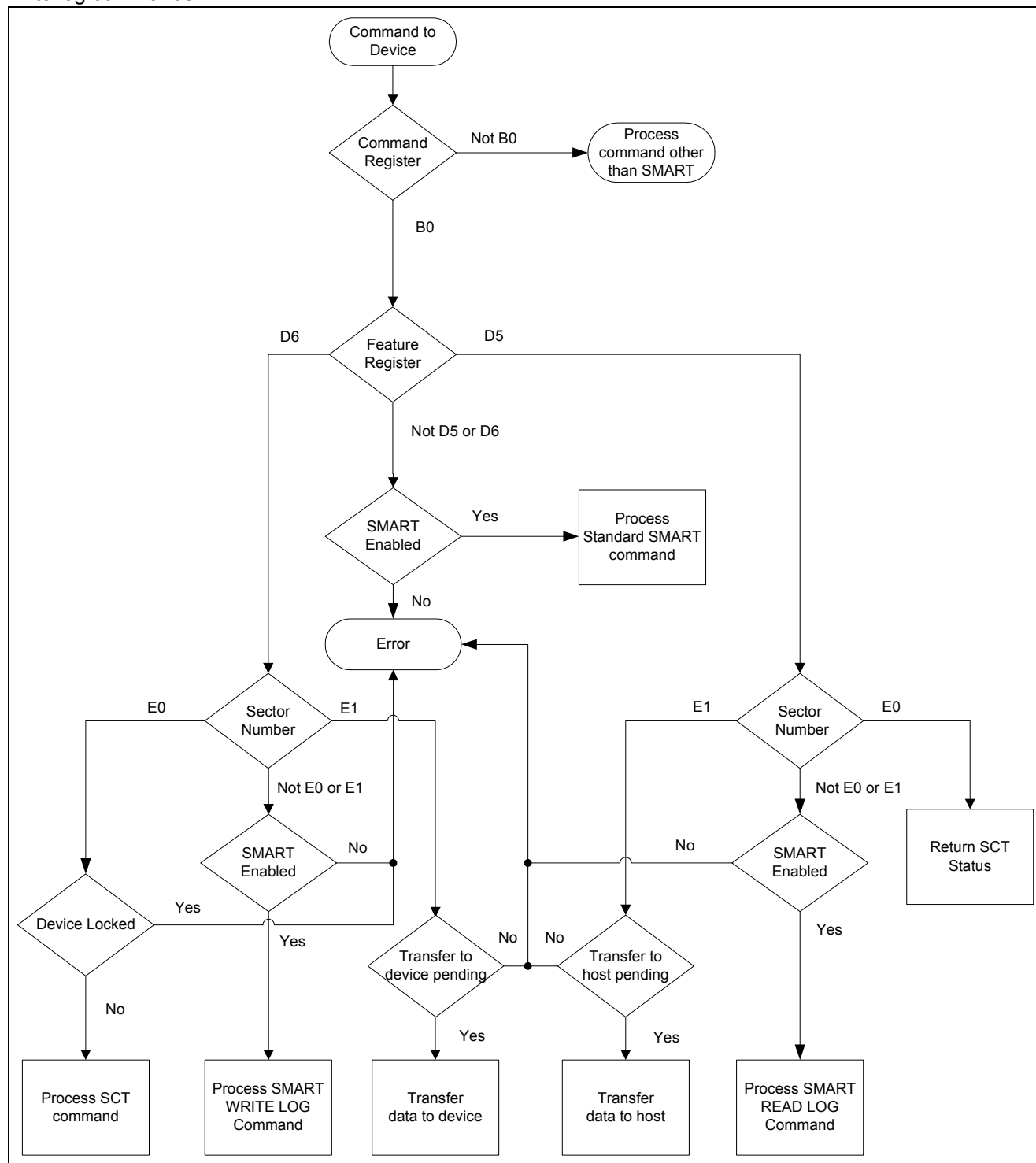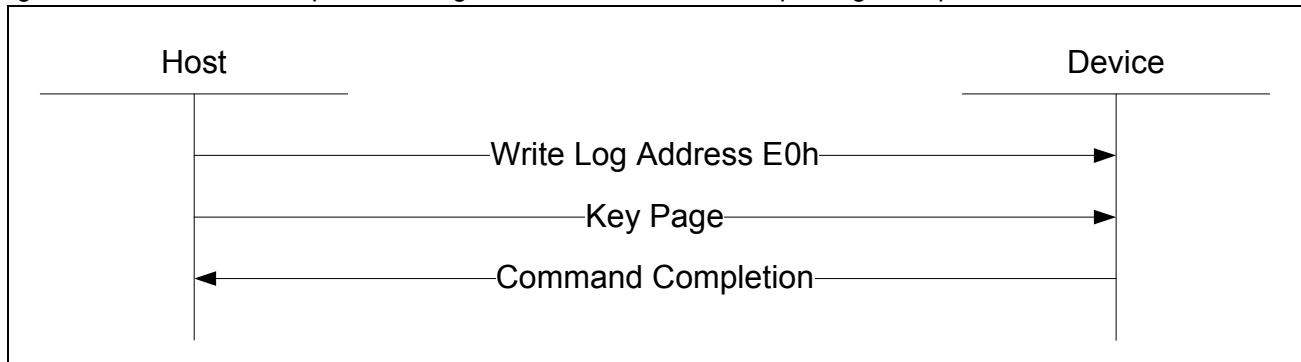

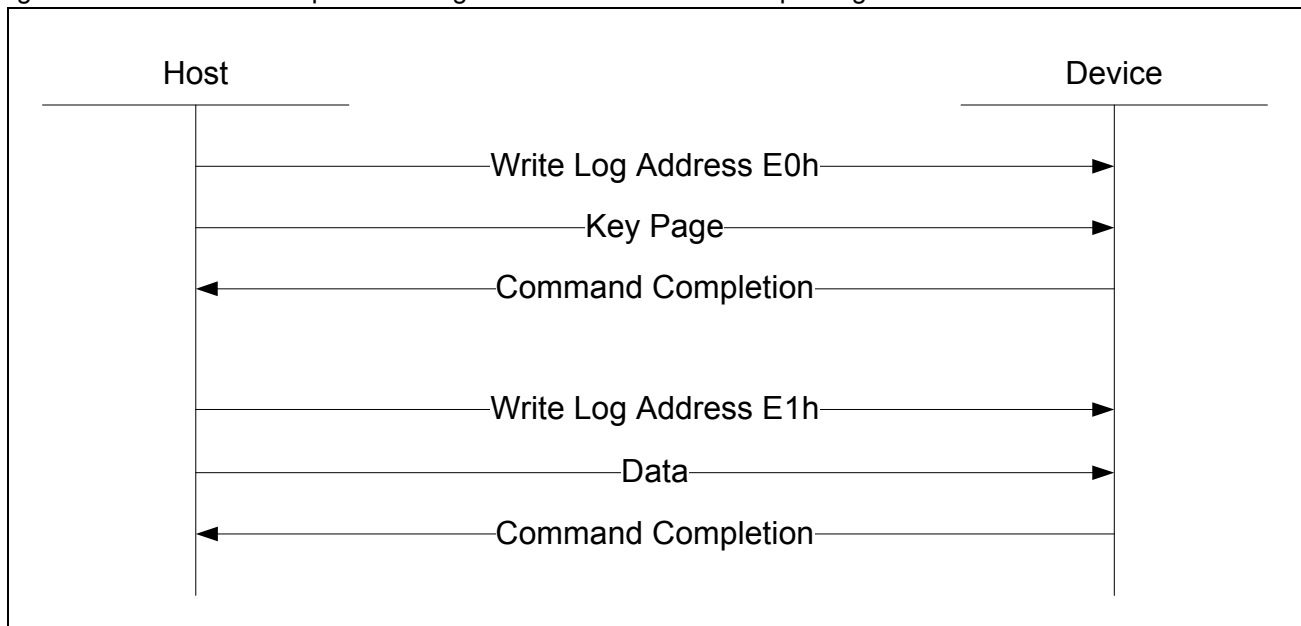**Figure D.1 — Example flowchart for SCT commands**

D.2 Examples of Log page command sequences

Figure D.2 shows an example of a foreground write same with a repeating write pattern.

Figure D.2 — Example sequence for foreground write same with a repeating pattern

Figure D.3 shows an example of a foreground write same with a repeating sector.

Figure D.3 — Example sequence for foreground write same with a repeating sector

Figure D.4 shows an example command sequence for writing data to a device using an SCT command with no background activity.
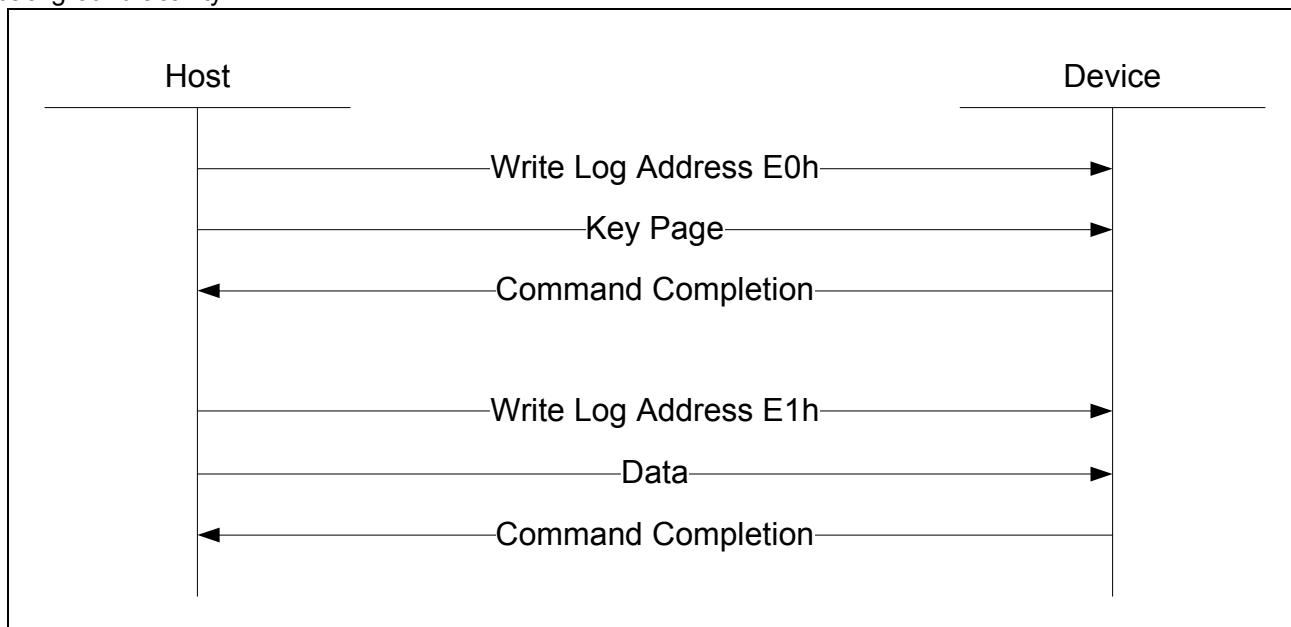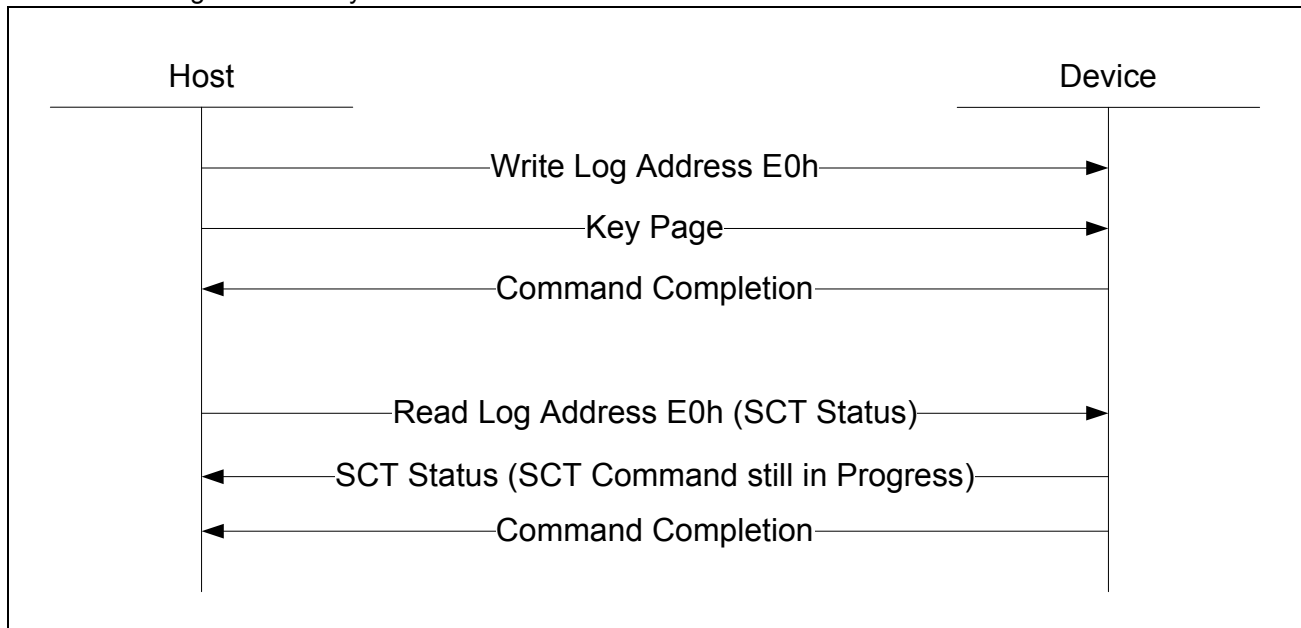

Figure D.4 — Example sequence for writing data using an SCT command with no background activity

Figure D.5 shows an example command sequence for reading data from a device using an SCT command with no background activity.
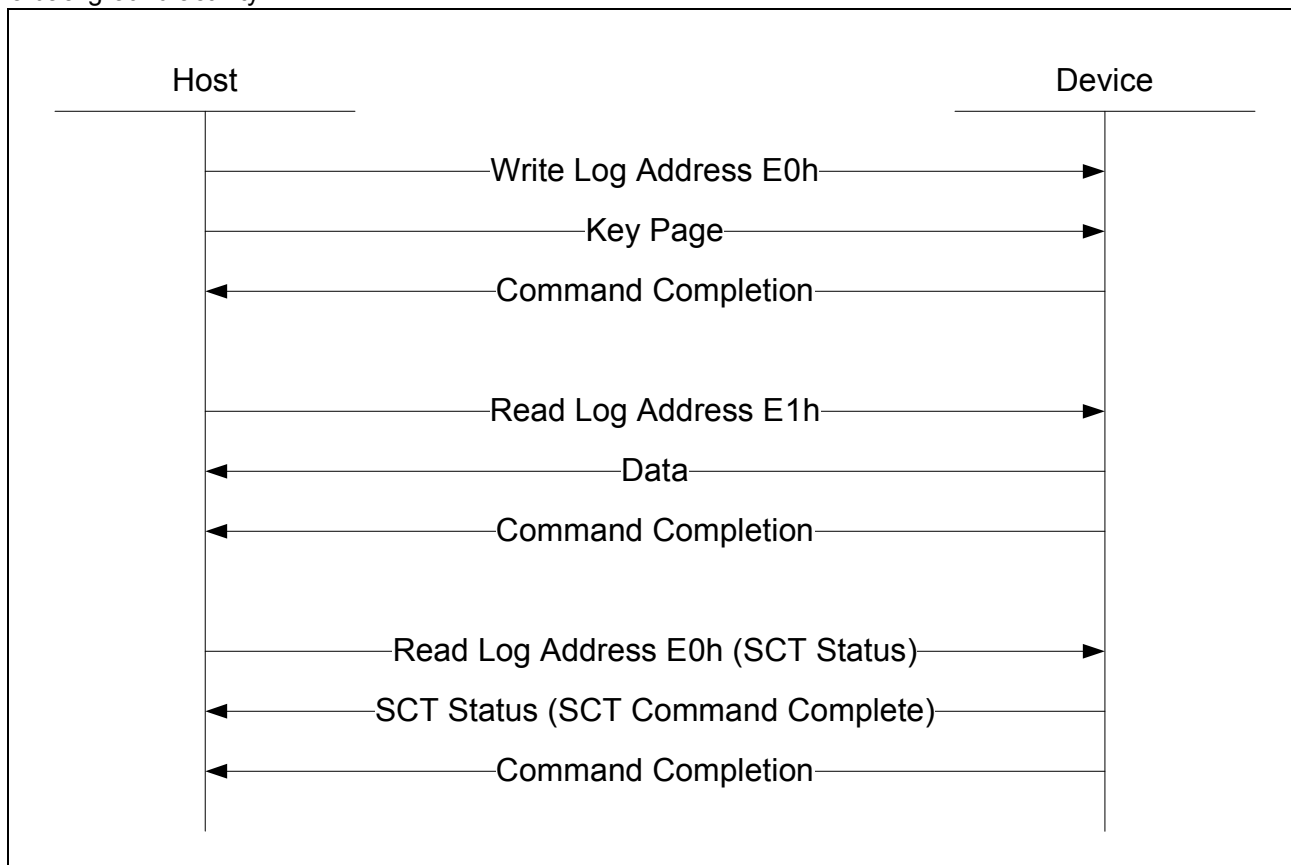
Figure D.5 — Example sequence for reading data using an SCT command with no background activity

Figure D.6 shows an example command sequence for issuing a Log page command that does not transfer data and has no background activity.

```
┌──────────────────────────────────────────────────────────────────────────┐
│                                                                            │
│        Host                                            Device              │
│   ─────────────┐                                 ┌──────────────          │
│                │                                 │                         │
│                │────────Write Log Address E0h───────────►│                │
│                │                                 │                         │
│                │──────────────Key Page───────────────────►│               │
│                │                                 │                         │
│                │◄───────────Command Completion───────────│                │
│                │                                 │                         │
│                │                                 │                         │
│                │──────Read Log Address E0h (SCT Status)──►│               │
│                │                                 │                         │
│                │◄──SCT Status (SCT Command still in Progress)──│          │
│                │                                 │                         │
│                │◄──────────Command Completion────────────│                │
│                │                                 │                         │
└──────────────────────────────────────────────────────────────────────────┘
```

Figure D.6 — Example Sequence for a Non-Data SCT command with no background activity

Figure D.7 shows an example command sequence for issuing an SCT command that writes data in the background.
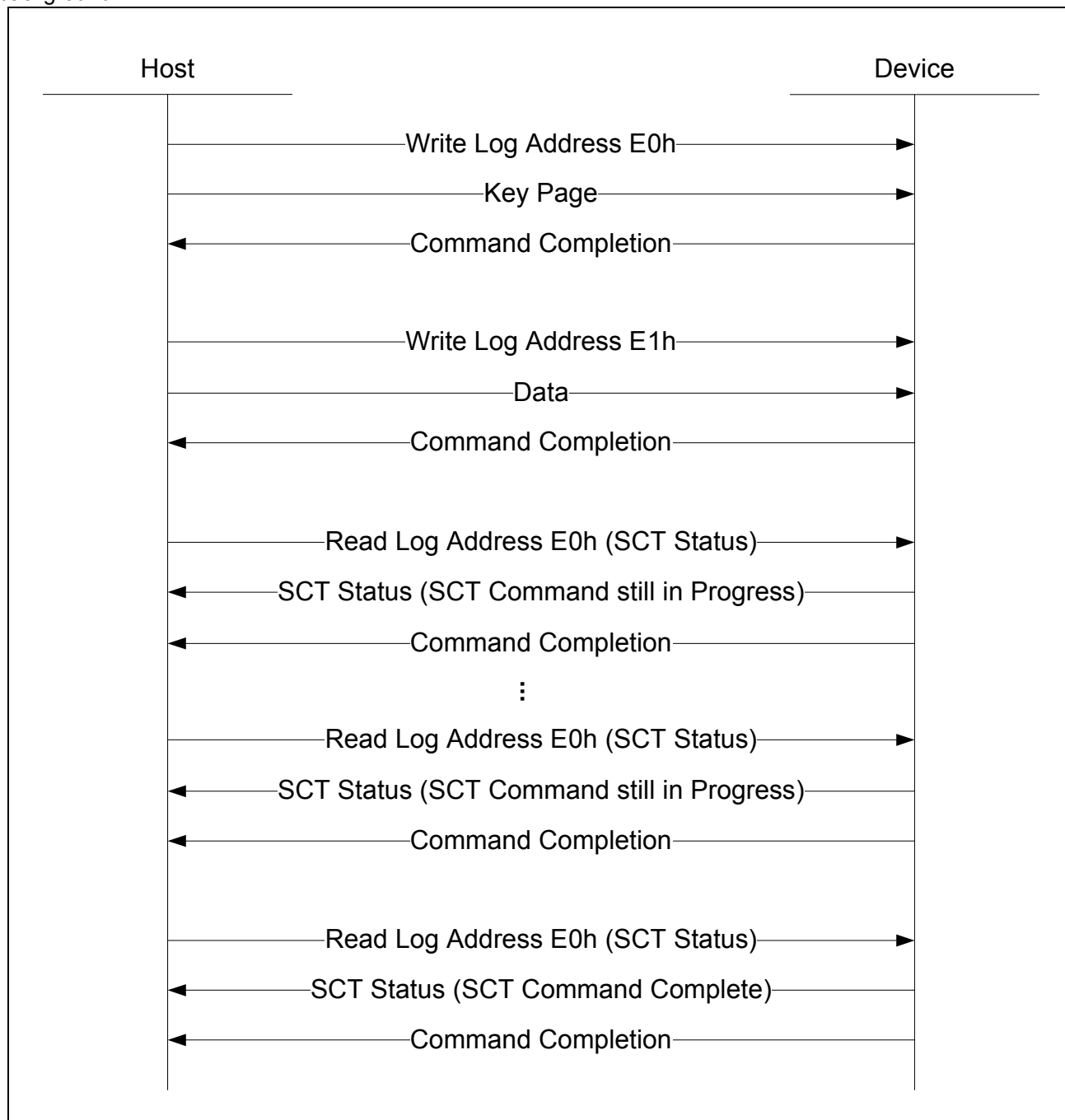

Figure D.7 — Example sequence for writing data using an SCT command with background activity

Figure D.8 shows an example command sequence for issuing an SCT command that is processed in the background but does not require the transfer of data to or from the host.
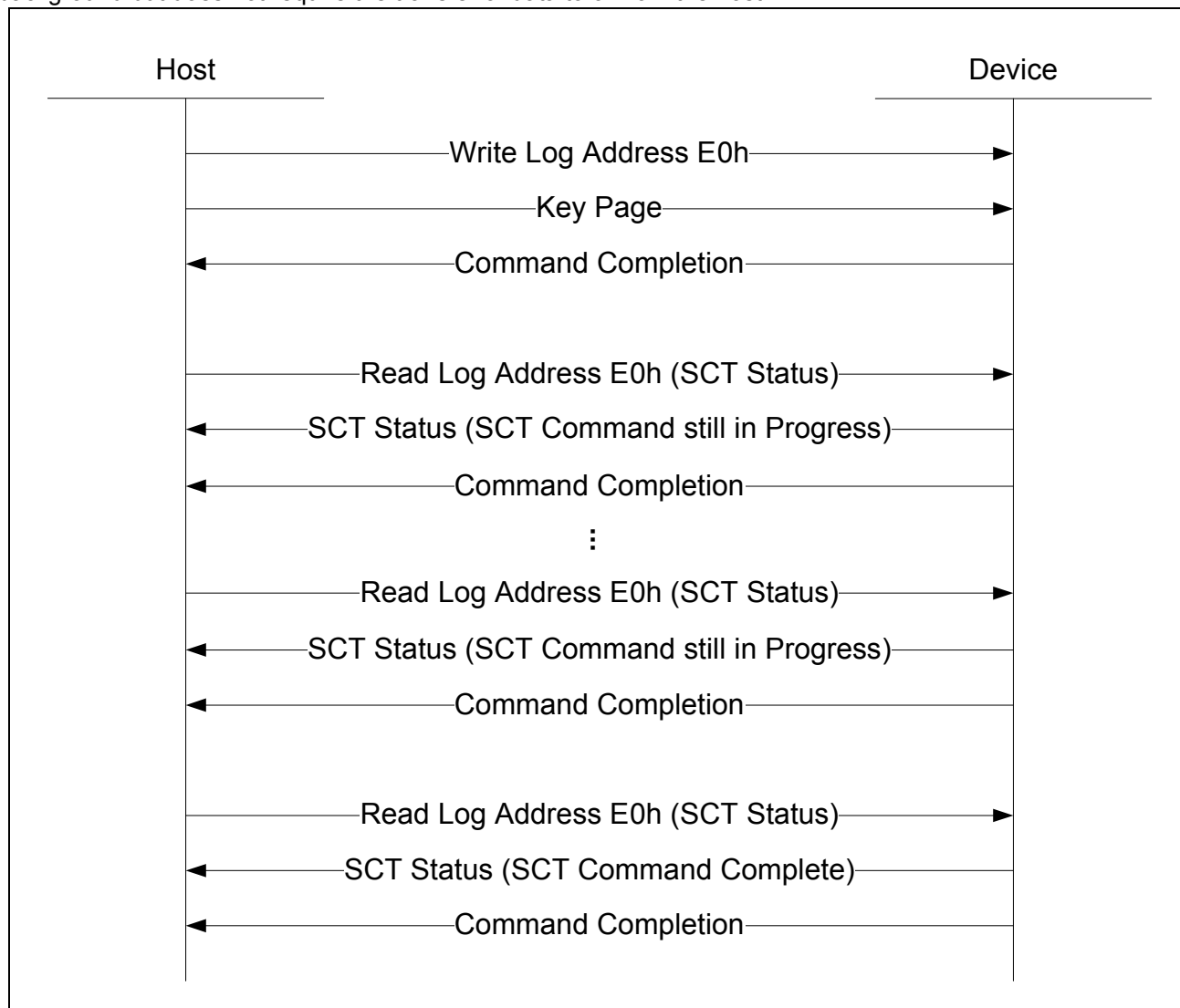

Figure D.8 — Example sequence for a Non-Data SCT command with background activity

D.3 Issuing an SCT command to a device

D.3.1 Step 1 - Build a Key Page

The host builds the key page in a host buffer for the appropriate action and parameters.

D.3.2 Step 2 - Issue the SCT command

The host issues the SCT command (see table D.1 or table D.2), and sends the key page to the device.

Table D.1 — SCT command using SMART WRITE LOG command

Name	Description
Feature	D6h (e.g., SMART WRITE LOG)
Count	01h
LBA	**Bit** **Description** 27:24 N/A 23:8 C24Fh 7:0 E0h (e.g., SCT Command/Status log address)
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B0h

Table D.2 — SCT command using WRITE LOG EXT command

Name	Description
Feature	Reserved
Count	0001h (e.g., one sector for SCT commands)
LBA	**Bit Description** 47:40 Reserved 39:32 00h 31:16 Reserved 15:8 00h 7:0 E0h (e.g., SCT Command/Status log address)
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 3Fh (e.g., WRITE LOG EXT) 57h (e.g., WRITE LOG DMA EXT)

If the SCT command is successful, then the device responds with successful status (see table 192) . If the command is aborted (i.e., Status = 51h and Error = 04h), then either the key page format is invalid, the command structure contains an invalid value or the command encountered a processing error . The host checks the Count field and LBA (7:0) field for the error code (see table 193 and table 194) . If the command was a write command, the command is terminated, there is no data transfer, and the host skips Step 3 . However, if the command was a read command, there may be partial output available (e.g., on a sector read command, the data up to and including the sector in error is available) and the host may proceed to Step 3 to get the partial data . In some cases the error is not fatal and serves only as a warning.

If the status is 50h, then the host checks LBA (23:8) . If LBA (23:8) is cleared to 0000h, then the command is complete, terminated without error, and the host proceeds to Step 4 . If the values are greater than 0, then the host proceeds to Step 3.

D.3.3 Step 3 - Transfer Data if Required

To transfer data from the device to the host, the host issues a SMART READ LOG command, READ LOG DMA EXT command or READ LOG EXT command to the SCT Data Transfer log (see table 195 and table 196) . To transfer data from the host to the device, the host issues a SMART WRITE LOG command, WRITE LOG DMA EXT command or WRITE LOG EXT command to the SCT Data Transfer log (see table 195 and table 196) . The transfer request is in the range of one sector up to the total number of sectors not yet transferred . The number of sectors remaining was posted in the LBA (23:8) field in the previous step . If the requested number of sectors is larger than the number of the sectors remaining, the device reports an error . If the value is less than the number of sectors remaining, the host may repeat Step 3 until all sectors have been transferred.

For SCT commands that access the media, the device advances the sector pointer by the number of sectors transferred, and reports in the LBA (23:8) field the number of sectors remaining to be transferred . If the Number of Sectors Transferred field and the LBA (23:8) field are set to zero, then the command is complete, and the host proceeds to Step 4 . The host has complete control over the number of sectors to transfer at a time . If the

number of sectors to be transferred is greater than or equal to FFFFh, the device sets LBA (23:8) to FFFFh . The value remains FFFFh until the number of sectors remaining drops below FFFFh . The exact number to be transferred is reported by the SCT Status command . Upon receiving the last block of data, the device performs the specified operation . In the case of very large amounts of data (e.g., SCT Write Same command) some data may be processed (e.g., written to the disk) prior to receiving all of the data from the host.

D.3.4 Step 4 - Final Status/SCT Command Completion

The host reads the SCT status response (see table 197, table 198, and table 199) to determine how the command completed . If the command has not completed (i.e., by reporting FFFFh in table 199 byte 14), then the host waits a vendor specific period of time and repeats Step 4 until the command is complete . For SCT commands that require transfer of data to the device (e.g., a write command), the command is not complete until the last block of data has been transferred to the device.

Annex E

(Informative)

## Implementation Guidelines For 1 024 and 4 096 Byte Sector Sizes

E.1 Scope

This annex provides guidelines for implementing a media format that incorporates sector sizes greater than 512 bytes.

The information provided in this annex enables sector sizes that are a binary multiple greater than 512 bytes . This standard also specifies methods to report sector sizes that are not a binary multiple . Common sector sizes that are not binary multiples include 520, 524, 528 and 532 byte sectors . Non-binary multiples are beyond the scope of this annex.

E.2 Overview

Figure E.1 shows major system components that are affected by a change in sector size.
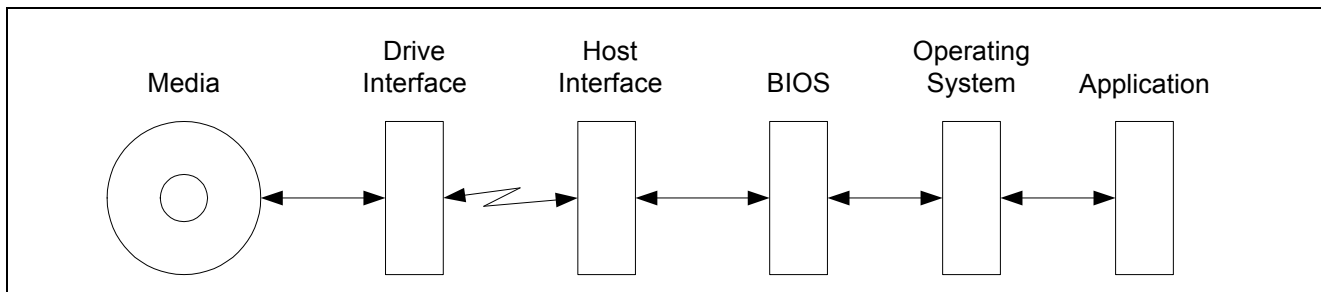
Figure E.1 — System Dependency Chain

The following methods may be used to expand the sector size:

- a) Native Physical Sector Size method (i.e., the physical sector size is seen at the drive interface); or
- b) b) 512-byte Emulation method (i.e., keeps the 512-byte logical sector size at the drive interface) . Figure E.2 illustrates these methods.

	Today	512-Byte LB[a]	Physical Sector Size LB[a]	512-Byte LB[a]	Physical Sector Size LB[a]
Interface Sector Size	512 Bytes	512 Bytes	1 024 Bytes	512 Bytes	4 096 Bytes
		Requires RMW, is compatible with the System Dependency Chain [b] chain	Incompatible with the System Dependency Chain [b], does not require RMW	Requires RMW, is compatible with the System Dependency Chain [b] chain	Incompatible with the System Dependency Chain [b], does not require RMW
Media Sector Size	512 Bytes	1 024 Bytes	1 024 Bytes	4 096 Bytes	4 096 Bytes

[a] Logical Block
[b] See figure E.1. The system dependency chain is evolving and may change to support logical sector sizes larger than 512 bytes.

Figure E.2 — Mapping Proposals

Using the 512-byte Logical Block method, the Drive Interface, Host Interface, BIOS, Operating System, and Applications still function . Optimal performance is achieved if the OS were modified to properly align the disk accesses . The 512-byte Logical Block method also allows a drive manufacturer to ship a utility with the unit that optimizes performance . If the Physical Sector Size Logical Block method is employed, the existing Drive Interface, Host Interface, BIOS, OS, and Applications may not function . The reason they may not function is that many components in the System Dependency Chain (see figure E.1) only support 512-byte logical blocks . If the host interface is able to transfer the data, it is likely that the BIOS is only implemented to handle 512-bytes logical blocks . If the BIOS does support the larger logical block size, it is likely the operating system is written to only handle 512-byte logical sectors . In the case where the BIOS or host interface only supports 512-byte logical blocks, no code may reasonably be used to fix the problem.

This standard specifies a method of aligning 512-byte logical sectors with larger physical sectors by specifying LBA alignment requirements using the IDENTIFY DEVICE command (see 7.18), the Long Logical feature set (see 4.13) and Long Physical Sector feature set (see 4.14) . Figure E.3 is an example of the capability specified in this standard.
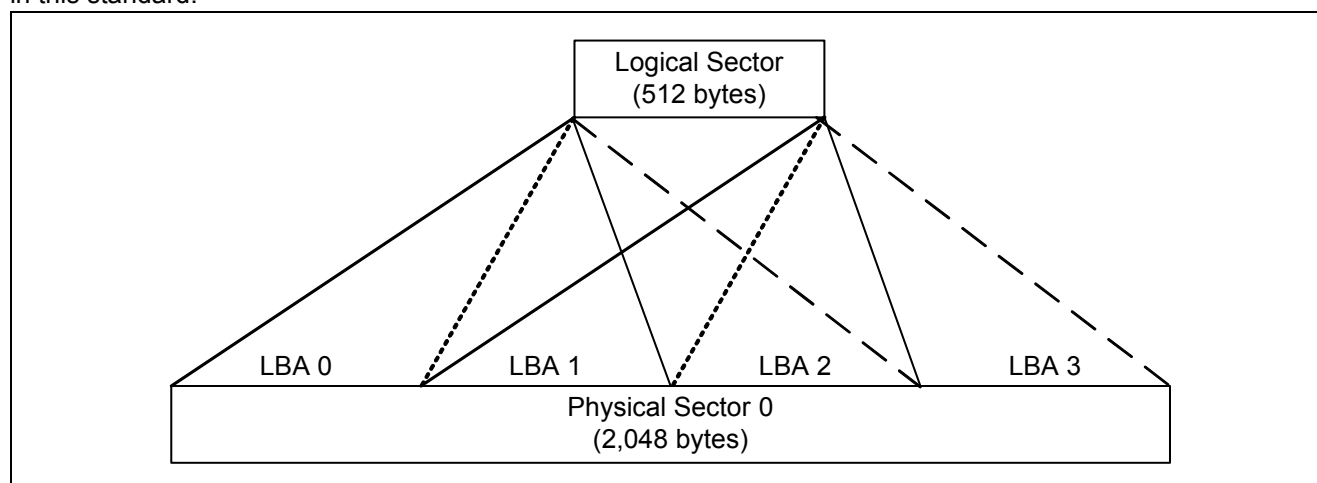
Figure E.3 — Logical Sector to Physical Mapping

In this example, the interface sector size (i.e., logical sector size) is 512 bytes, and the physical sector size is 2 048 bytes . This allows an ATA device to both implement a larger physical sector and maintain compatibility with existing systems, interfaces, and software . One of the drawbacks of this method is that drive performance may suffer if the host writes data starting or ending on an LBA that is misaligned with respect to the physical sector boundaries . When misalignment occurs, the drive is forced to perform a Read-Modify-Write (RMW) operation in order to satisfy the host request.

This standard also allows the ATA device to report that a Logical Sector size is the same as a physical sector size . This allows an ATA device to implement a native 4 096-byte sector on the media and requires that transfers be 4 096 bytes of data for each logical block requested . This method avoids RMWs . The main drawback of this implementation is that existing systems, interfaces, BIOS and system software, OS and otherwise, have to change in order to accommodate the device.

E.3 Implementation

E.3.1 4 096-Byte Sector Size Implementation

The 4 096-byte physical sector size allows for greater format efficiencies, however, 4 096-byte physical sectors causes alignment issues.

The device indicates a 4 096-byte sector size to the host by:

a) returning 6003h in IDENTIFY DEVICE data word 106 (see 7.18.7.56) indicating that the device has eight 512-byte logical sectors to compose a 4 096-byte physical sector . The host may use this information to know that transfers should start with an LBA where the low order 3 bits are zero and the transfer ends on an LBA where the low order 3 bits are one; or

b) returning 5000h in IDENTIFY DEVICE data word 106 and 0800h in IDENTIFY DEVICE data words 117..118 (see 7.18.7.61) indicating that the device has one 4 096-byte logical sector per 4 096-byte physical sector . The host may use this information to know that transfers require 4 096 bytes per logical block requested.

E.3.2 Reporting Alignment (512-Byte LBA Only)

This standard defines the ability to report alignment by placing the sector number of the first alignment point in IDENTIFY DEVICE data word 209 (see 7.18.7.76).

If the drive reports a 4 096-byte physical sector and a 512-byte logical sector, the following IDENTIFY DEVICE data word 209 values report the alignment:

a) if word 209 = 4000h, then LBA 0 is aligned to the beginning for the first physical sector;

b) if word 209 = 4001h, then LBA 0 is offset from the start of the first physical sector by 512 bytes (i.e., 1 sector);

c) if word 209 = 4002h, then LBA 0 is offset from the start of the first physical sector by 1 024 bytes (i.e., 2 sectors);

d) if word 209 = 4003h, then LBA 0 is offset from the start of the first physical sector by 1 536 bytes (i.e., 3 sectors);

e) if word 209 = 4004h, then LBA 0 is offset from the start of the first physical sector by 2 048 bytes (i.e., 4 sectors);

f) if word 209 = 4005h, then LBA 0 is offset from the start of the first physical sector by 2 560 bytes (i.e., 5 sectors);

g) if word 209 = 4006h, then LBA 0 is offset from the start of the first physical sector by 3 072 bytes (i.e., 6 sectors); and

h) if word 209 = 4007h, then LBA 0 is offset from the start of the first physical sector by 3 584 bytes (i.e., 7 sectors).

For systems that use Windows[®] XP and earlier, and have devices formatted with a single partition, the optimal value is 4001h .

Windows$^{®}$ XP and earlier do not check the logical sector size field or physical sector size field reported in IDENTIFY DEVICE data (see table 54).

E.3.3 Read-Modify-Write (RMW) (512-Byte LBA Only)

For devices with a logical sector size of 512 bytes, the drive may be forced to perform RMW when it receives an unaligned transfer . Write commands do not provide a way to return an error other than an Abort (see 6.3.2) or a Device Fault (see 6.2.7) . If there is an uncorrectable error encountered during the initial read operation, the Write command has no way to report the issue . This error may affect logical sectors not accessed by the Write command . There are several possible solutions to choose from in providing the information to the host . Figure E.4 shows the issue.
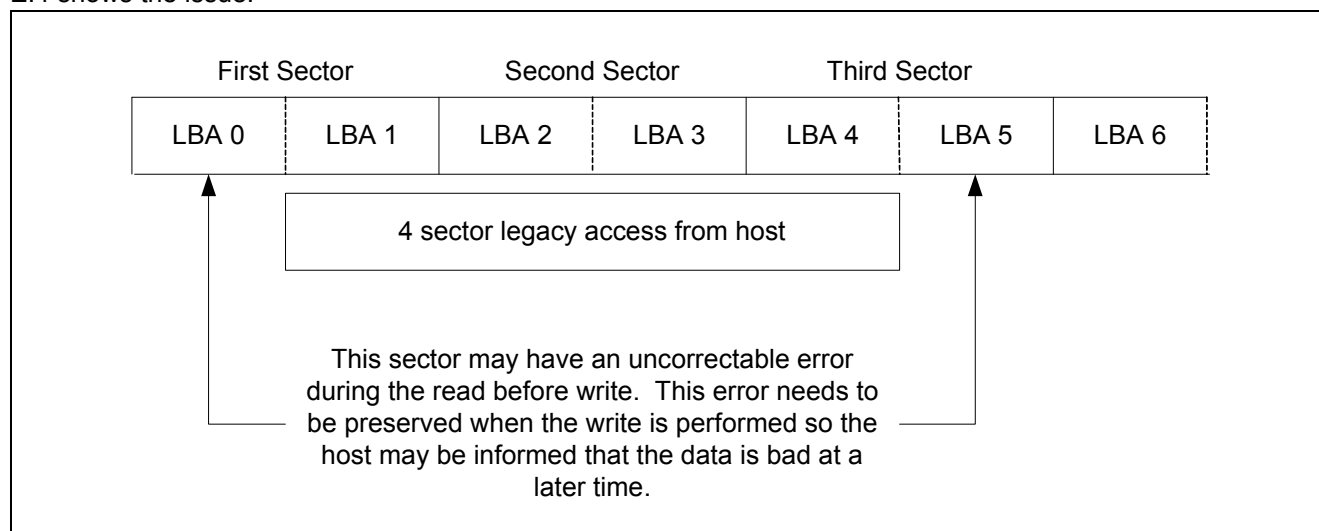

Figure E.4 — Uncorrectable Error Handling

E.4 Implementation Issues (512-Byte LBA Only)

E.4.1 Overview

Although the implementation described here allows a drive to function in a legacy system without modification, there are some issues that are critical in allowing the drive to perform at peak efficiency . Figure E.5 describes a typical device media layout showing the positions of the Master Boot Record (MBR), BIOS Parameter Block (BPB), and the remainder of a FAT based file system . This layout varies based on the type of FAT file system used, but all the elements described here are generally present . The sector numbers on the left hand side of the

figures show typical and/or legacy locations for the various data structures on the media . The following sections describe alignment issues associated with current media layout.
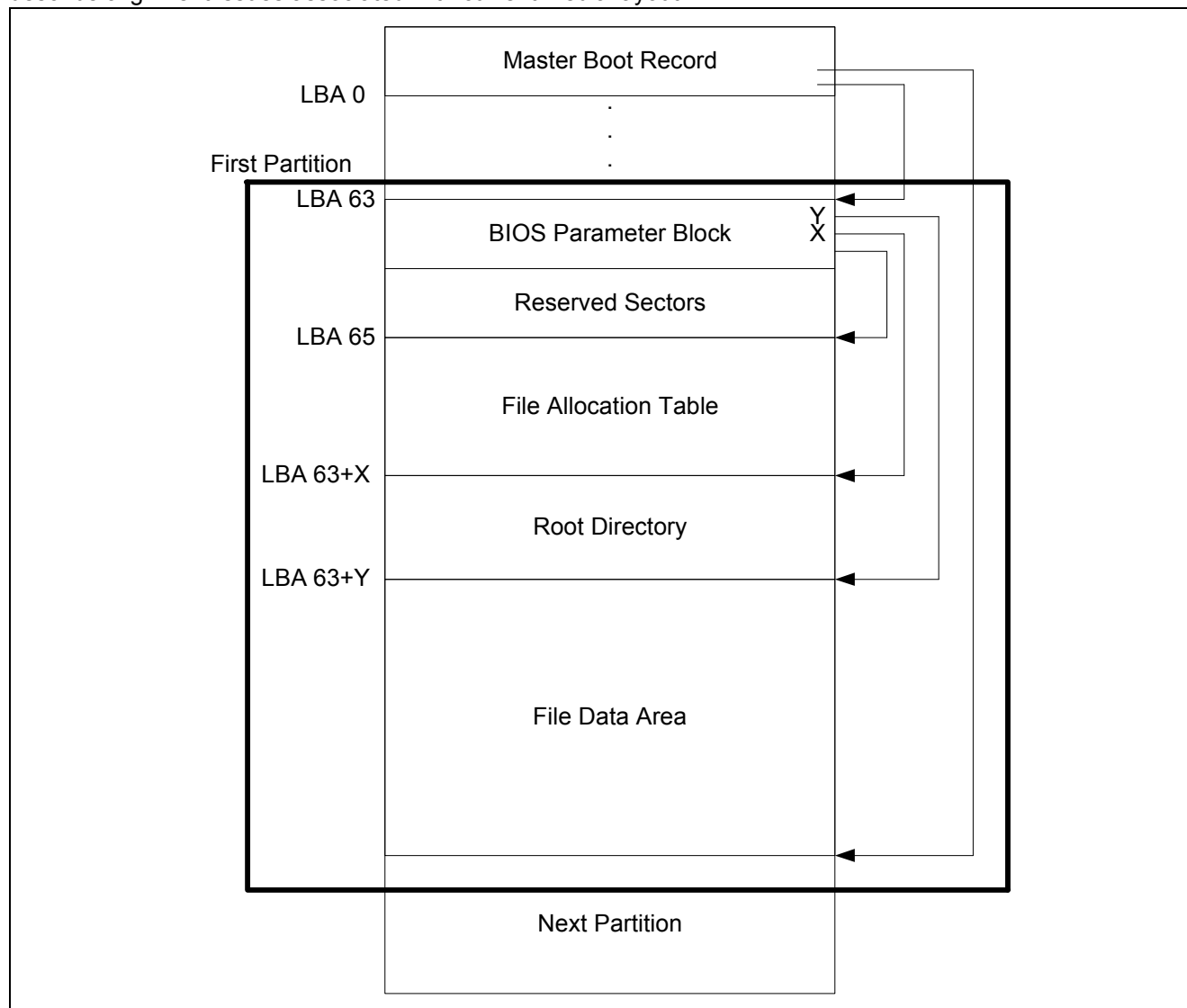
Figure E.5 — Typical HDD Layout Using A Master Boot Record

E.4.2 Drive Partitioning

In 1993 when the HDD industry was still dealing in cylinders heads and sectors, an important milestone was reached that caused drive manufacturers to standardize on 63 sectors per track . The norm for disk partitioning software was to place the Master Boot Record (MBR) at Cylinder 0, Head 0, sector 1 (or LBA 0) . The MBR contains a pointer to the first partition . The common practice was to place the first partition at Cylinder 0 Head 1, sector 1 . This meant that the LBA value of the first sector in the first partition may vary . Once the sectors per track standardized on 63, the LBA value of the first sector in the first partition standardized on LBA 63 . Today, there are some applications that check to make sure that partitions start on a track boundary, even though there is no meaning for cylinders heads and sectors.

As we move forward and create larger sectors, partition alignment becomes an important issue . In the case of a 1 024-byte sector device, the partitions should start on an even numbered sector and end on an odd numbered sector . If the drive implements a 4 096-byte sector on the media, then the partition should start on an LBA where the low order 3 bits are zero.

For drives that use 512-byte LBA, all partitions should start on an LBA that is aligned with the start of a physical sector on the media . This affects some applications that check to make sure the first partition starts on sector 63, but a change is required to implement larger sectors on the media.

E.4.3 File System Formatting

There are many file systems that cluster sectors together to create an allocation unit larger than a single 512-byte sector . These file systems generally implement a table to associate clusters with files, commonly called a File Allocation Table (FAT) . A typical cluster size is 4 096 bytes (i.e., eight 512-byte sectors) . Even if the Partition is properly aligned, there is an issue where the size of the FAT may cause the individual clusters in the File Data Area to be unaligned relative to the physical sectors on the media . This also results in performance degradation.

If the clusters in the file system are properly aligned, file accesses is naturally aligned in many cases and performance is not degraded.

E.4.4 Virtual Memory accessing

Once the clusters in the file system are aligned, the OS memory manager needs to be modified to prevent unaligned accesses . When a drive has alignment requirements, disk performance tests may show acceptable performance, but if the virtual memory activity is not aligned, CPU performance tests may provide unacceptable results.

E.4.5 Booting

The drives with alignment requirements should not show significant performance degradation on unaligned reads . Since booting is mainly a reading process, an impact on system boot times in an unaligned environment is not expected.